PUBLIC WORKS

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"RUST INSURANCE"

is what McWane Precalked Joint Cast Iron Pipe really is. Above is a 1¼-inch cast iron line being "man-handled."

Being McWane-cast, it requires no coddling. Having genuine Precalked joints, it tightens automatically under deflections.

Once in the trench, it will carry water by the century. Rust will never harm it. Its cost *per year* will be less than for any other pipe.

Use McWane pipe for parallel mains in residence districts to avoid crossing under paving with services; use it for services down-town; and for every small line where permanence pays.

Sizes: 1¼ through 8 inches.

McWane Cast Iron Pipe Company

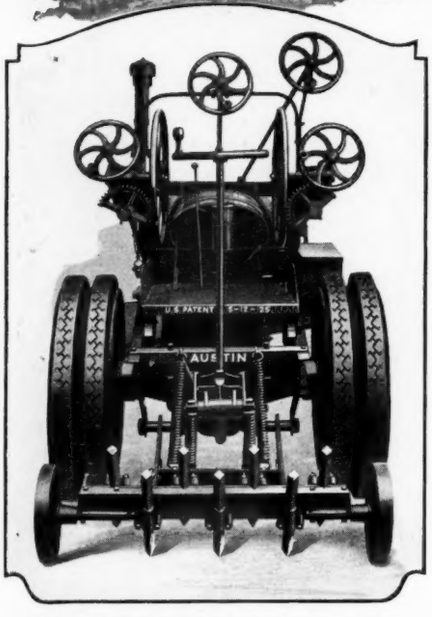
Birmingham, Ala.

819 Bankers' Trust Bldg., Philadelphia, Pa. 1807 Santa Fe Bldg., Dallas, Tex.

208 S. LaSalle St., Chicago, Ill.

Pacific States Cast Iron Pipe Co., Provo, Utah 608 Subway Terminal Building, Los Angeles, Calif.

JUNE, 1927



Rear type of scarifier used on Austin Motor Graders. This attachment is exceedingly useful in scarifying roads that are too hard for the grader blade, thus greatly increasing the capacity of the machine.

LEVELING OFF THE ROUGH SPOTS

THAT'S the job usually assigned to Austin-International Motor Graders—and that's exactly what they do. If it's a badly rutted gravel road the Austin-International (15-30) will cut right down to the bottoms of the corrugations leaving a smooth, hard surface once more suited for high speed traffic. Not only that but it has sufficient speed and blade length (12 ft.) to do the work quickly and inexpensively.

Leaning Front Wheels

Besides having the operator stationed at the rear of the machine, which is now generally conceded as the only logical place for him to stand, Austin Motor Graders are also equipped with leaning front wheels which overcome the side draft on the blade and hold the grader to a straight course, besides enabling it to work in ditches and on side slopes where a straight wheeled machine would be useless.

Special Equipment

Austin Motor Graders are built in three sizes using the International (15-30), International (10-20) and Fordson for their power. All three sizes may be had with plain steel wheels, rubber tired wheels, or crawler tread, and with either center or rear scarifier.

A new catalog describes Austin Motor Graders in detail. Write for your copy today.

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VOL. 58 NO. 6

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PUBLIC WORKS

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

Vol. 58 June, 1927 No. 6

Durham's New Water Works

Large Impounding Reservoir Holds Equivalent of Three Years' Consumption. Eighty-foot Dam Provides Power for Dumping and Other Purposes. Upward Hydrostatic Thrust on Dam Eliminated. Many Unusual Features in Design. Provision for Studying Rainfall, Run-off, Evaporation and Silting of Reservoir.

By D. M. Williams*

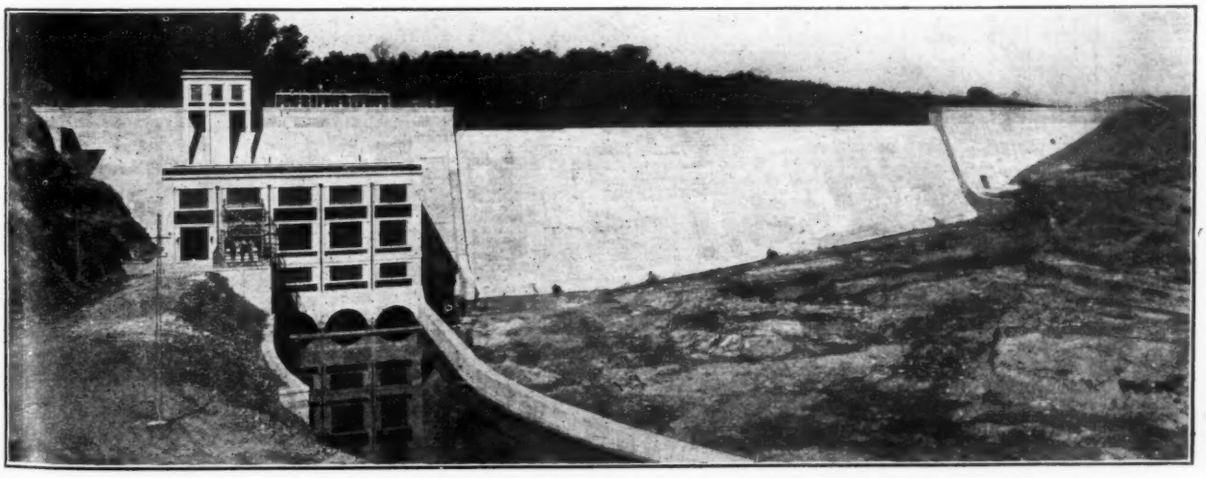
The City of Durham, N. C. in 1921 found that, with an average daily consumption of three million gallons, the flow of the Flat river, from which it drew its supply, had a flow in September of only 1.37 m.g.d., in October of only 1.45 m.g.d. and in November of 1.7 m.g.d. For 130 days, from August 16th to December 24th, the entire flow of the stream was pumped to the city, and resort was had also to a plant on Eno river, which had been abandoned in 1917 when the city began obtaining its supply from Flat river

Flat river has a drainage area of 172 square miles, and the minimum flow in September, 1921, was equivalent to 0.0123 cu. ft. per second per square mile. During September, 1925, the daily flow fell to less than a million gallons, or to 0.009 c. f. s. per square mile. Few flow data of this river were available in 1921, but such as were had indicated a minimum flow of 8 million gallons. When this figure was found to be much too high an exhaustive study of the water supply problem was made, including other sources of supply and sites on the river for a reservoir.

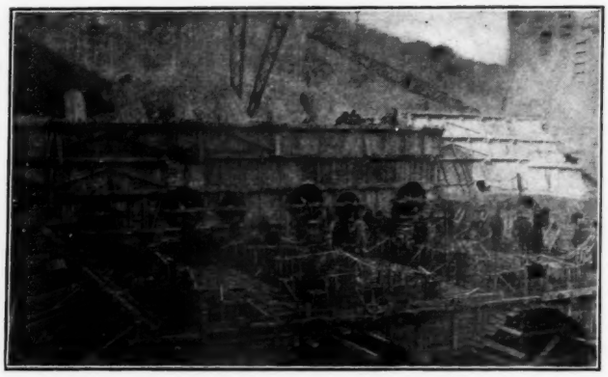
The most desirable site on Flat river was found to be one mile above the pumping station, where a dam 60 feet high would create a lake covering 287 acres and containing 1900 million gallons. Under normal growth this would take care of the situation for twelve to fifteen years. A dam 80 feet high, the ultimate for the site, would create a lake covering 547 acres and containing 4600 million gallons. This would supply the demands for an indefinite period.

As Durham is growing rapidly, has a number of large industrial plants, and its water consumption is increasing by leaps and bounds, it decided to build the higher dam and forget about water short-

*Assistant engineer, Wm. M. Piatt, consulting engineer, Durham, N. C.



FRONT VIEW OF FLAT RIVER DAM AND POWER STATION
Dark spots at bottom of spillway section are underdrains. Tunnel entrance at right of spillway. Earth embankment at extreme right.



POURING FIRST STATION FLOOR
Thimbles and forms for flumes in background.
Plenty of labor insured quick placing of concrete

ages, thus setting an example not only for North Carolina cities but for the entire South.

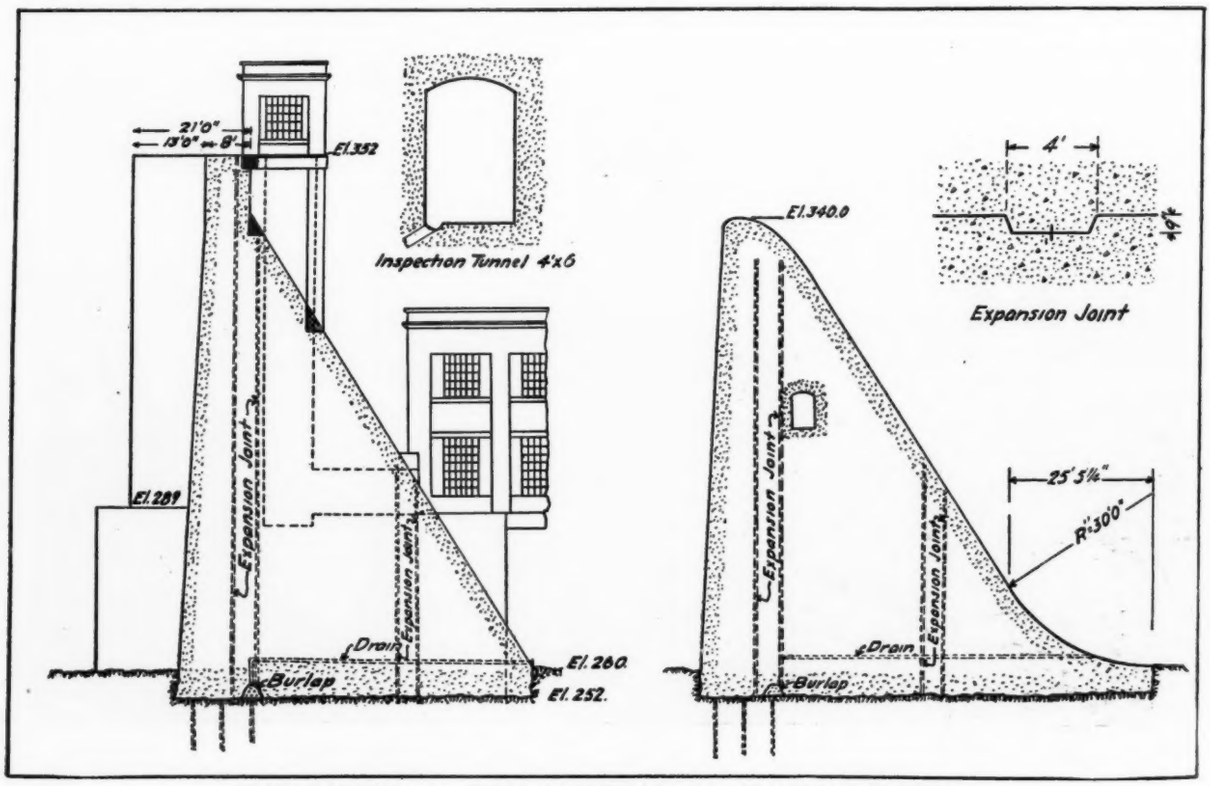
The mean annual rainfall at Durham is some 44 inches and runs as high as 49.5 inches at some of the gauging stations in the immediate vicinity. Flat river at the dam site drains 170 square miles and during dry periods the run-off drops to nearly nothing and is correspondingly high during the wet season. With a dam 80 feet high abundant supply would be available at all times and the surplus water could be converted into power at a very low additional cost. A large quantity of power is needed to pump the water from the river to the filtration plant and from the filtration plant to the consumer; besides, a ready market was available for a large quantity of secondary power.

The development of this power was authorized and a contract entered into with the Durham Public Service Company for the sale of surplus power generated and for the purchase of power when needed.

Water had previously been pumped from Flat river by steam turbine driven centrifugal pumps through about 11½ miles of 20-inch pipe to a 46,000,000 gallon storage reservoir at the filtration plant, which is located on the outskirts of the city. The pipe line parallelled the highway most of the way, and surveys developed that a straighter line would eliminate one and one-half miles. The friction loss in the 20-inch line was very heavy and it was recommended that a 30-inch line be laid from the proposed new plant to the old plant and an additional 24-inch line from the old Flat river plant to the filtration plant. A right of way was purchased 50 feet wide along the new location, for pipe line and transmission line purposes, but the pipe line laying was temporarily withheld.

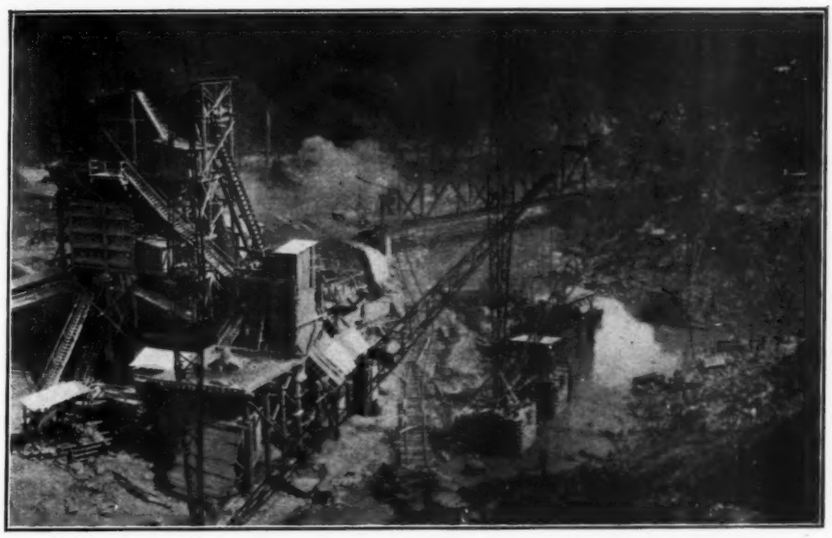
PREPARATION OF FOUNDATION

Before bids for the dam were received the site was cleaned up and twenty-six test holes were dug to ascertain the definite location of the structure, the depth to foundation and the class of material encountered. These pits varied in depth from fourteen to twenty-six feet through an overburden of earth and loose rock and to what appeared to be good foundation. In addition to these pits, 1,350 lineal feet of core drillings were made. The rock encountered was gneiss, very seamy and broken up, which necessitated deep excavation for foundation and cut off.



CROSS-SECTIONS OF WEST BULKHEAD AND SPILLWAY SECTIONS

To further safeguard against leakage, two lines of holes five feet on centers staggered were drilled near the heel of the dam and filled with pure cement grout forced in under pressure. These holes varied in depth from twenty to thirty feet and extended over the entire length of the masonry section. Many subterranean crevices and seams were encountered and where it was deemed necessary additional holes were drilled and grouted. The largest amount of grout forced into any one hole was twenty-six bags, most of them taking from two to six bags. After these holes had been grouted and the cement had set, another row of 20-foot holes were drilled five feet further down stream and ten feet on centers, to relieve upward thrust. Over this line of holes a continuous line of one-man and crushed stone was placed to maintain communication. In order to prevent the voids filling with concrete, the stone was covered with burlap. Vertical risers eight inches square spaced twenty feet on centers were extended from this up to within ten feet of the spillway, each of which was connected for drainage to a tunnel which extends through the spillway section, and four of these risers were vented to the toe of the dam.

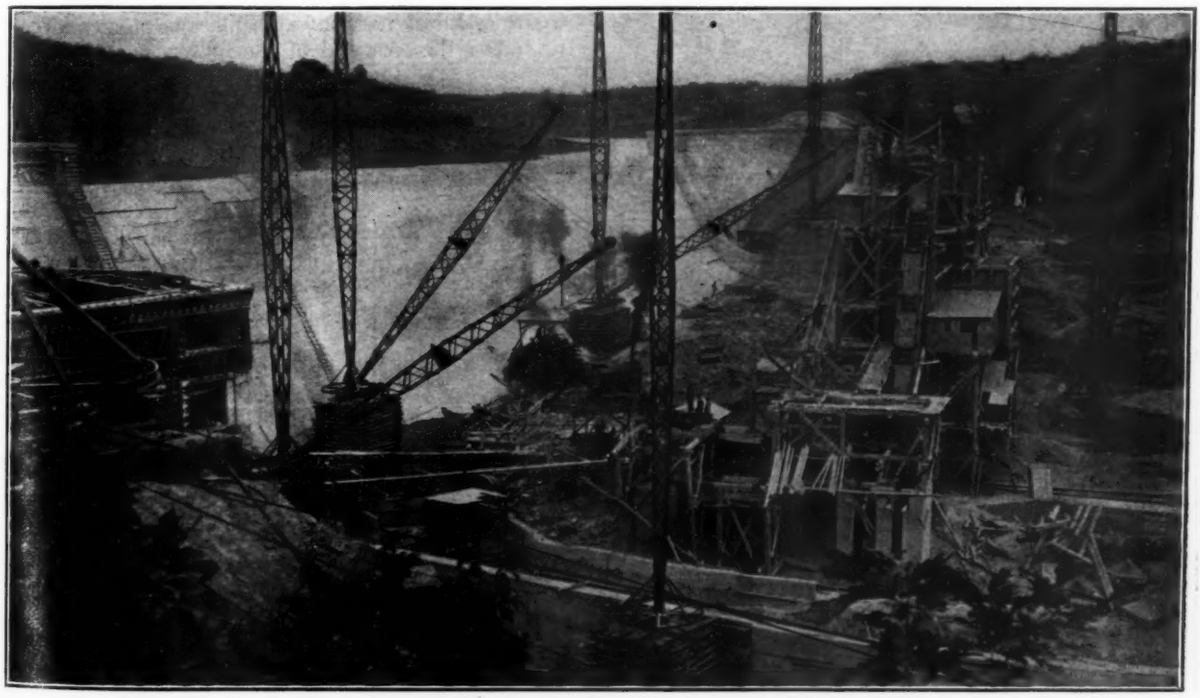


CONTRACTOR'S COMBINED CRUSHER AND CENTRAL MIXING PLANT
Bridge in background part of construction railway.

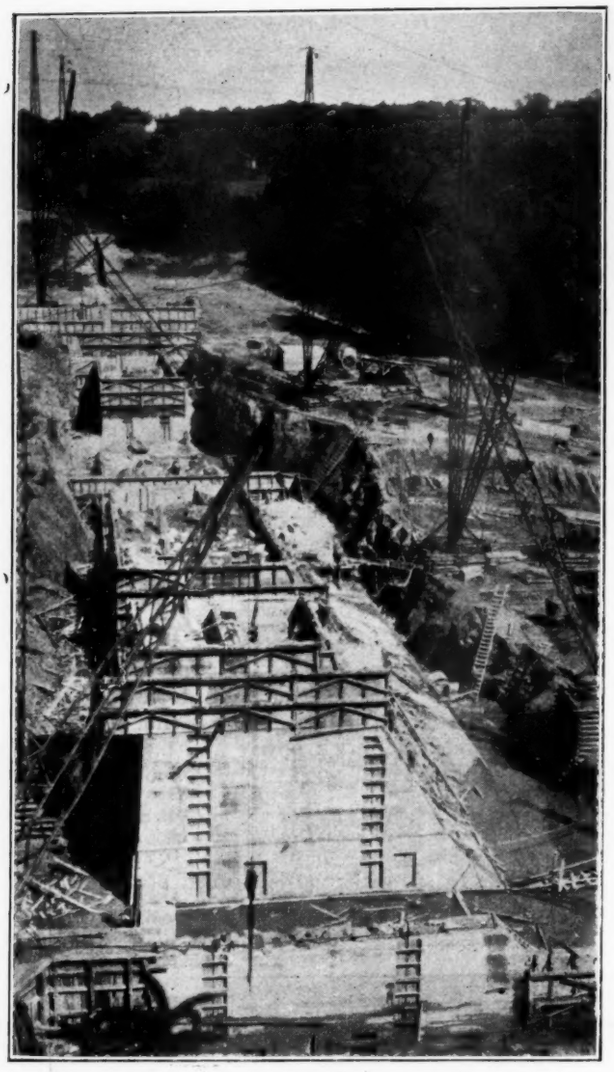
THE DAM

The dam crosses the river in an east and west direction. The main part is of masonry of the gravity spillway and bulkhead type, with an earth fill and core wall section on the east end. A reinforced concrete and brick power and pumping station was built integral with the west bulkhead section.

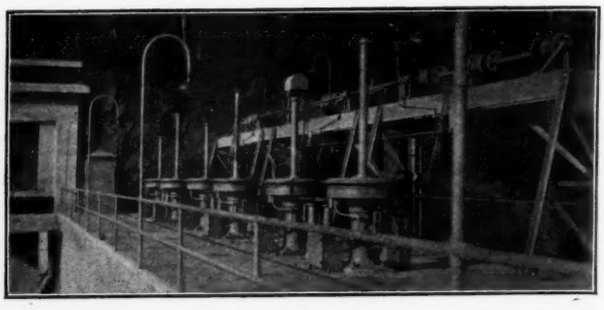
The masonry in the dam is class "C" 1:3:6 concrete and stone from one-man size to stones containing five to six cubic yards, spaced not less than six inches from the forms and each other. The



DAM COMPLETE. STATION AND TAILRACE UNDER CONSTRUCTION
Lake filling (note water in background). Tearing down crusher and mixing plant.



LOOKING EAST ACROSS DAM SHOWING EARLY CONSTRUCTION
Note expansion joints. Seventeen steel derricks reached every part of the work.



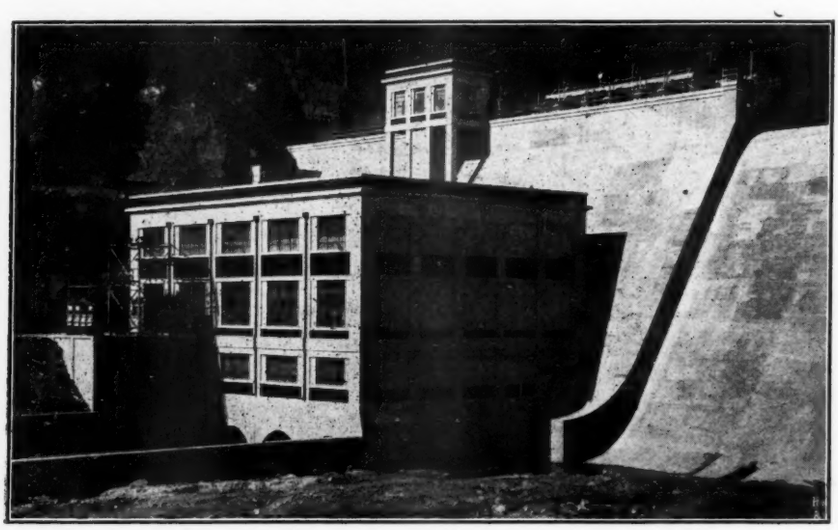
INDIVIDUAL MOTOR OPERATED SLUICE GATE HOISTS AND TRASH RACK RAKE SUPERSTRUCTURE
Small house for water level recording gauge at left background.

stone contents amounted to about 35 percent. The splash walls, tail-race walls, core wall and power house piers were made of 1:2½:5 concrete and one-man stone. The retaining intake walls and power house were made of 1:2:4 reinforced concrete.

All stone was quarried and crushed on the site. Sand rolls were installed in the crusher plant which furnished about 25 per cent of the sand used, the balance being shipped in. The mixing plant was built integral with the crusher plant and contained a battery of two two-yard batch mixers discharging into two-yard buckets placed on standard railroad flat cars, which were switched out to the dam and the concrete placed in the walls by derricks.

The masonry dam was built in sections with expansion joints approximately 75 feet apart, each joint contained two 1x4-foot offsets. In the center of each offset was placed a ½-inch by 8-inch flat steel with four inches embedded in the first pour of concrete. After the forms had been stripped the other four inches was painted with asphalt before concrete was poured against it.

The material for the earth fill was obtained from the hill at the east end of the fill and was placed in 12-inch layers, wetted and rolled. Where it was impractical to properly roll the fill it was puddled. The earth fill was built up 20 feet above the spillway elevation with a crest 20 feet wide and having a slope of 2½ to 1 on the downstream side and 3 to 1 on the upstream side. The upstream face of the fill was protected from wave wash by covering it with rip rap eighteen inches deep.



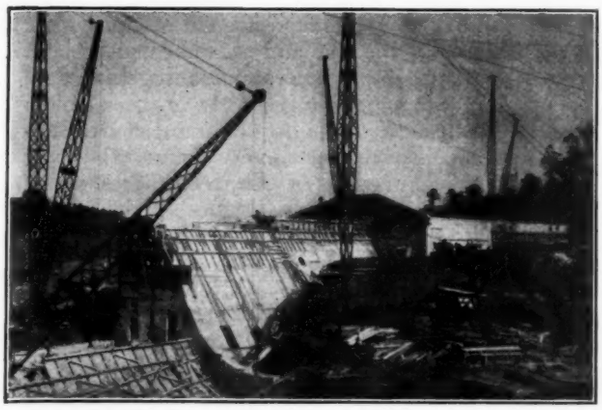
VIEW OF STATION AND WEST END OF SPILLWAY
Sub-station at lower left. Elevated tower and intake structures on bulkhead. Splash wall at end of spillway.

THE POWER HOUSE

The power house is 77 feet wide, 103 feet long and 74 feet high, and contains the following equipment:

Three 500 kw. 80% power factor, 2300 volt, 3 phase, 60 cycle, 514 r.p.m, vertical water wheel driven generators. The hydraulic governors controlling these units have motor operated pumps, motor operated balls, and motor operated synchronizing control.

An eleven panel switchboard with manually operated circuit breakers and having all high-tension equipment mounted on pipe frame structures at the rear of the switchboard. All rheostats are



EAST RETAINING WALL AND BULKHEAD SECTION
Practically complete. Teams making earth fill.

chain operated and are mounted on the frame above the switchboard.

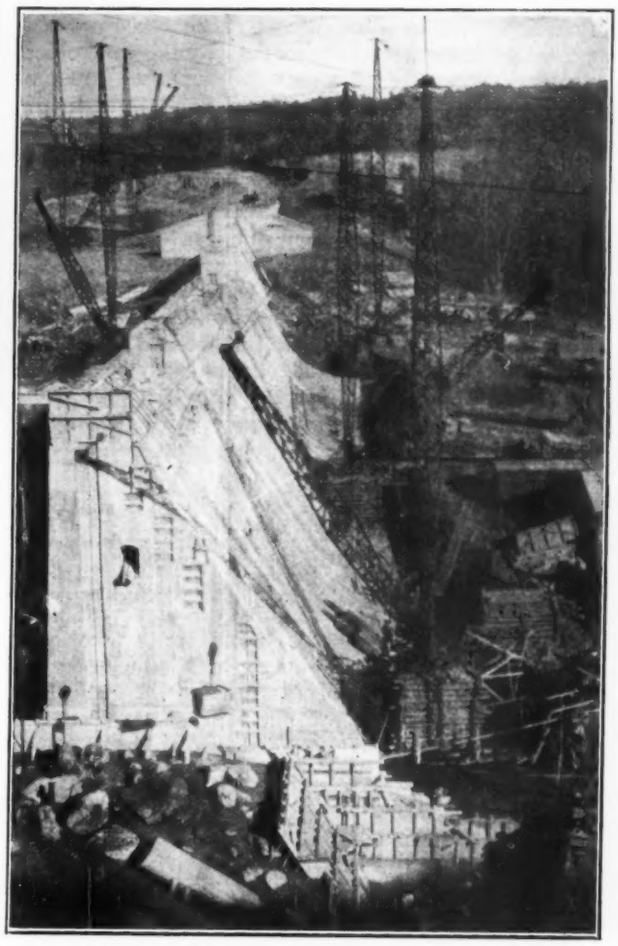
Two—5000 gallon per minute, 150 foot head, 990 r.p.m., centrifugal, direct connected water wheel driven pumps, with provision for a third unit.

Two—5000 gallon per minute, 150 foot head, 1200 r.p.m., centrifugal pumps direct connected to 300 horsepower, 3 phase, 60 cycle, 2300 volt synchronous motors, with provisions for a third unit.

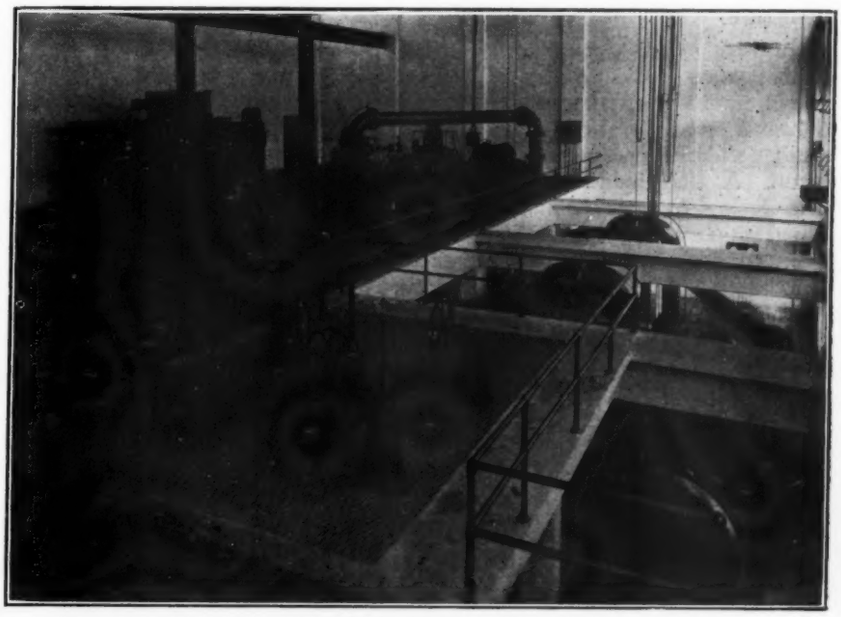
Six flumes connect to the intake, three being 60-inch and three 42-inch. Each 60-inch flume supplies water to a generator unit. When the plant is complete each 42-inch flume will have connected to it suction for one motor-driven pump, suction for one water wheel driven pump, and supply to the water wheel driving one pump. A gate valve cuts water off the water wheel when it is not in operation. The suction line to each pump contains a twin strainer which can be cleaned readily while the pump is operating. The pumping head and delivery of the pumps are for delivery through the present 20-inch and an additional 24-inch line from the old station to the filtration plant, but the piping allows for series operation until the 24-inch line is laid, and after that in case of one line being cut out for repairs, etc.

By-passes between suction and discharge of pumps and cross connections at the steam station allow the steam station to pump direct from the lake so that when it is necessary to run this station the head in the lake can be utilized.

A 15-ton, 58-foot span traveling crane traverses lengthwise the building and the building is so constructed that every piece of heavy equipment can be handled by the crane. This feature was obtained by the use of subway gratings over certain flumes and cross connections in pipe line headers, and by removable precast concrete floor slabs where the



SPILLWAY SECTION AND RETAINING WALL PRACTICALLY COMPLETE
Note tunnel through spillway section, and forms for flume line.



STATION INTERIOR
Switchboard, generators, motor driven pumps and tunnel entrance in background. Water wheel driven pumps and piping on lower floor. Subway grating in foreground covers pipe cross connections, valves operated from main floor. Cross connections in pump piping for either separate or series operation.

floor is subject to heavy loads. The space not traversed by the crane contains the switchboard, office, venturi meters, etc.

A tunnel leads from the station through the spillway section to the opposite side of the river.

An electrically operated one-ton elevator operates betwen the main floor of the station and the top of the dam. The elevator shaft is cored out of the dam and the masonry thus saved practically paid for the cost of the elevator.

Recording gauges record water height in the lake and in the tailrace. The wells for these gauges were cored out of the masonry and are connected to water outside by small pipes. The well for the head gate gauge is sixty-two feet deep.

On the water wheel floor is a spacious bathroom containing a shower bath, room and water being heated by electricity.

On the main floor is a 10 x 20 foot steel and glass office which is heated by electricity.

The intake consists of three separate bays, each 17 feet wide and 62 feet high and separated from each other by a 3-foot reinforced concrete wall. Each bay contains a 60 x 42-inch inlet with individual motor operated sluice gates which can be operated by hand if necessary, and 12-inch hand operated priming gates. The flumes are ventilated by 12-inch round shafts, cored out of the masonry and covered with perforated cast iron manhole rings. The trash racks extend the entire height of the intakes and are made up of ¼ x 4-inch flat iron welded to 3x 3 angles and spaced ¾-inch between bars and supported by an I-beam structure. Provision was made for stop log gates in front of the trash racks for use in case of emergency. The racks are cleaned by motor operated rakes, a separate rake for each bay with a single motor for the three; the motor, cable drums, drive and counter shafts, etc., being supported on a steel frame superstructure.

Between the intake and west bank is a 10 x 20-foot floating dock for motor boats. This dock is made up of steel drums connected together with I-beams and floored with 2-inch oak timbers. Steel guides slide in tee shaped slots cored in the masonry wall. A steel ladder leads from the bulkhead to the dock. Two davits made up of four-inch bent pipe, supported by standard sluice gates guide bearings bracketed to the masonry, allow ready means for handling small boats from the lake to the dock and to the bulkhead.

GAUGING AND OTHER STATIONS

As stated above, there were practically no dependable stream flow data to be used in ascertaining the available water in the stream, especially for minimum flow. The city appropriated necessary funds for constructing five stations; two with recording gauges in the river, one at the head of the lake and one below the plant; and three stations with rod gauges on small tributaries entering the lake; all of which required construction of weirs. These stations were constructed and are being operated by U. S. Geological Survey together with the North Carolina Department of Conservation and Development.

In order to study silt deposits, ten sections were established across the lake and monumented on both sides. The data from these sections, together with topographic maps of the lake, have been taken over by the North Carolina Department of Conservation and Development and the Engineering School of the University of North Carolina, which will from time to time make studies of the silting. The North Carolina Department of Conservation has placed a rain gauge at the dam and a number on the watershed. It has also an evaporation pan in the lake and a wind gauge on the dam.

The station is named "Lake Michie Power Plant" as a token of appreciation of over thirty years of faithful service of Colonel J. C. Michie as superintendent of water works at Durham.

UNUSUAL FEATURES

Some of the features of this development rather out of the ordinary, at least for this section, are:

One—Large impounding reservoir for municipal water supply—4,600,000,000 gallons—which, if used for no other purpose, would, at the present rate of consumption, supply the demand for a period of three years.

Two—Combination pumping and power plant containing vertical generators, horizontal water wheel driven pumps, and motor driven pumps.

Three—Accessibility of handling all machinery, valves, piping, etc., with traveling crane.

Four—Flexibility of operating pumping units, including steam stations one mile away, namely: single pump will supply present demand through two pipe lines by operating fourteen hours a day; with only one line, as at present, friction loss is so great that two pumps run in series is necessary and provided for. The piping connections permit the use of the steam plant one mile down stream to pump from the lake with a positive suction head instead of twenty feet suction lift.

Five—Underdrain system for relieving upward thrust.

Six—Tunnel communicating from station through spillway to opposite side of river.

Seven—Electrically operated elevator to top of dam.

Eight—Individual motor and hand operated sluice gates.

Nine—Recording lake and tailrace gauges with wells cored out of the masonry.

Ten—Floating dock for motor-boats.

Eleven—Mechanically operated trash rack rakes.

Twelve—Stream gauging stations above lake and in channel below tailrace.

Thirteen—Preparation for studying silting.

Fourteen—Rain gauges over the entire water shed.

Fifteen—Evaporation pan for measuring evaporation in lake.

Sixteen—Wind gauge.

CONTRACTS AND CONSTRUCTION

The construction comprised the following quantities required for the development:

Eleven miles 22,000 volt transmission line.

One 1500 Kva. 2300/22,000 volt substation and one 2000 Kva. 2300/22,000 volt substation.

1290 tons pipe for one mile of 30-inch line and station piping.

453 acres of clearing in lake.

15,000 cubic yards excavation for road and 85,656 cubic yards excavation for dam and station.

43,153 cubic yards earth fill.

5564 square yards rip rap.

83,141 cubic yards class "C" masonry, 1330 cubic yards class "B" masonry, and 1600 cubic yards class "A" masonry.

84 tons reinforcing steel and 152 tons structural steel.

The switchboard, trash racks and all machinery were purchased erected and contracts for same were awarded in March, 1924.

Contracts for sundry materials and for construction work were awarded in the latter part of June, 1924, as follows:

Generators and switchboard—Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.

Vertical water wheels, flumes & governors—S. Morgan Smith, Co., York, Penna.

Pumps and the water wheels driving pumps—Worthington Pump & Machinery Corp, Harrison, N. J.

Motors and substations—General Electric Company, Schenectady, N. Y.

Trash racks & rakes—Newport News Shipbuilding & Dry Dock Co., Newport News, Va.

Sluice and gate valves—Chapman Valve Manufacturing Co., Indian Orchard, Mass.

Check valves—Eddy Valve Company, Waterford, N. Y.
Relief valves—Golden Anderson Valve Co., Pittsburg, Pa.
Pipe & Fittings—Lynchburg Foundry Co., Lynchburg, Va.
Transmission line material—Western Electric Co., Chicago, Ill.
Wiring material—Carolina States Electric Supply Co., Charlotte, N. C.
Reinforcing steel—Knoxville Iron Co., Knoxville, Tenn.
Recording water level gauges—W. & L. E. Gurley Co., Troy, N. Y.
Pressure gauges—American Schaeffer & Budenberg Corp., Brooklyn, N. Y.
Dock—O. Z. Wrenn & Co., Charlotte, N. C.
The Hardaway Contracting Company, Columbus, Ga., was awarded the contract for all construction work and for furnishing all materials not listed above.

Work started immediately on clearing the lake and building the transmission line and constructing a railroad to handle material from the Norfolk & Western Railway to the dam site for construction purposes. The railroad ran by way of the river pumping station and over the roadway graded between this station and the dam. The railroad was not completed till early spring, 1925, due to right of way difficulties and wet weather.

The first concrete was poured July 20th, 1925, and the dam was completed April, 1926, in time to store enough water to prevent a water famine during the fall and early winter. The entire construction was completed in October, 1926.

William M. Piatt, consulting engineer, Durham, N. C., was the engineer. Mr. Piatt's assistants were D. M. Williams, H. P. Redding and W. D. Linton, Jr.

Calcium and Magnesium Hydrates as Coagulating Agents

Martin E. Flentze, superintendent of waterworks, Oklahoma City, Okla., in the Journal of the American Waterworks Association, described the use of excess lime for reducing the amount of coagulants required. This article was abstracted for the Public Health Engineering Abstracts by O. M. Bakke, as follows:

The water used at Oklahoma City is aerated, softened with lime, clarified with iron and alum, settled, carbonated with flue gas, filtered and chlorinated. Formerly only sufficient lime was added to reduce the alkalinity to 50 ppm. causing little or no reduction of magnesium.

For eight months sufficient lime was added to give excess from 6 to 12 ppm. This caused a reduction of from 15 to 20 ppm. of magnesium, reduced the amount of coagulants required to nearly one-third and effected a saving of $3.57 per million gallons. Jar tests using the settled silt from the raw water with and without magnesium chloride and distilled water showed that magnesium hydroxide acted strongly as a coagulating agent and was largely responsible for the effect.

Value of excess lime as a sterilizing agent was also considered with possibility of reduction of the chlorine dosage. Reduction of B. coli with this amount of lime was somewhat disappointing. Sufficient lime was also tried for complete magnesium precipitation and elimination of other coagulants. The increased cost of lime was greater than the cost of the coagulants.

Sodium Aluminate for Elimination of Colloidal Interference

A report by A. R. Moberg, in bulletin No. 18 of the Research Department, Chicago Chemical Co., regarding the elimination of colloidal interference by the use of the aluminate-alum method of coagulation, was abstracted for the Public Health Engineering Abstracts by R. E. Tarbett, as follows:

The sodium aluminate-alum method of coagulation was developed to offset the inhibitory influences of colloids in connection with coagulation of water. The presence of colloids may call for excessive amounts of alum with or without alkalies or acids in order to produce proper coagulation. For the most part colloids in waters of the United States have been found to be negatively charged although a few have been found positively charged. Where colloids are negatively charged the addition of alkalies inhibits the alum reaction and acid accelerates it. The reverse is true of positively charged colloids. A small amount of sodium aluminate in connection with alum treatment appears to offset the inhibitory action of the colloids and allows for smaller alum doses. Too great an excess of sodium hydroxide in the sodium aluminate solution will prevent the phenomenon and the action will be the same as if sodium hydroxide and alum were used.

The use of aluminate-alum with the reduced alum required does not appear to affect the pH values.

Repairing Leaky Artesian Wells

An artesian well near Woonsocket, S. D., was reported to have a pressure of 250 pounds per square inch at the head; a well near Roswell, N. M., flowed 5,710 gallons per minute, or about 8 million gallons per day. With such pressures and yields, it appears that much water may be lost through leaks in well casings. Recently the Geological Survey has developed a practical means of locating the leaks and measuring the water lost through them.

The method is very simple in principle. A current meter that was specially constructed for the purpose by Carl H. Au, of the Geological Survey, is let down into the well, where it records the velocity of the water at any depth desired. With the velocity and the diameter of the well known, the rate of flow at any point can be determined. Hence a series of measurements taken at successive

levels from the bottom to the top of the well will show just where the water enters and in what amounts, where it leaks out and in what amounts, and how much is delivered at the surface. For certain investigations it may be necessary to devise apparatus for measuring the diameter of a well at any depth, but thus far no serious difficulties have arisen on account of uncertainty as to the diameter.

This method has now been successfully used in the artesian area of Honolulu, and in the Roswell artesian basin, in the Pecos Valley of New Mexico. In Honolulu the artesian water is especially valuable, because it forms the principal supply for the city. In 19 defective wells in Honolulu a total underground leakage of 7,750,000 gallons a day was found, which is equal to about one-third of the total quantity of artesian water consumed from the public waterworks. One of the wells was found to waste 750,000 gallons a day by underground leakage. A somewhat expensive program of recasing or plugging all leaky artesian wells has been undertaken, and the value of the work already completed is indicated by the fact that leakage amounting to 5,900,000 gallons a day has been effectively stopped. The experience on this project has shown that recasing and plugging leaky wells are difficult and expensive operations, which require the services of a skillful driller with adequate equipment, working under the instructions of a competent hydraulic engineer.

The methods used in these investigations are described in reports by John McCombs and A. G. Fiedler, which have been published by the Geological Survey as Water-Supply Paper 596-A.

Imhoff Tank Gases and Odors*

Collection of gases and reduction of odors from the sewage disposal plant at Decatur Illinois.

William D. Hatfield†

The odor situation at the Decatur sewage plant has been serious because of the strength and high temperature of the sewage received. Due to a large volume of condenser water from the starch manufacturing company, the temperature of the sewage varies from 70 degrees Fahrenheit in winter to 104 degrees in summer. The strength of the sewage has varied from 500 to 1000 p.p.m. of bio-chemical oxygen demand (5 days) depending on the grind of corn and efficiency of recoveries at the starch works. When the starch works is not operating the bio-chemical oxygen demand is about 125 p.p.m. This high temperature combined with strong sewage is ideal for bacterial decomposition and putrefaction which takes place rapidly in the sewers, filling them with unusually putrid gases and making the sewage as received at the plant very odoriferous.

The seriousness of the odor situation was equaled only by that of the treatment of the very strong sewage. A careful analysis and study of both problems have been made since the opening of the sewage plant three years ago. The preliminary experimental work on the treatment of this sewage and the testing station results have been reported to this society previously and in this paper I will stick to the odor situation.

During the first year of operation of the Decatur plant it was found necessary to build a gas tight flap door on the sewer entrance to the grit chamber. This door held back a large volume of sewer gas which had poured into the atmosphere at this point. This was the first step toward housing-in the odors. It was soon realized that all turbulent places in the conduits must be covered, and plans for housing-in the grit chamber were a very early part of the odor reduction program. This was later augmented to include covering all conduits, by-passes and points of agitation of the sewage.

Because of the extreme penetration of these odors, we felt that it would be impossible to keep the odors entirely housed-in. Along with the plans for covering went a suction and deodorizing system. The early plans included treatment of the housed-in sewer gases with chlorine, ozone, soda-chlorine washing systems, iron oxide filters or some other chemical treatment. Up to this time the high hydrogen sulfide content of the Imhoff digestion gases had not been appreciated. Numerous attempts to detect it by the nasal method had led us on the wrong track as will be seen by analyses made later.

Analyses about the plant were made of the air and gases to determine the hydrogen sulfide content. In this way the major sources of odor production were found to be, (1) the sewer gas coming from the mouth of the sewer at the entrance of the grit chamber, (2) the gas given off from the turbulent sewage at the outlet end of the grit chamber, (3) gas given off from the turbulent effluent of the Imhoff tanks at the sprinkling filter by-pass, (4) the digestion gases from the Imhoff tanks, (5) and from the sprays and stones of the sprinkling filters.

The relative intensities of the odor from the different points were probably in the order given

*Paper before the Illinois Society of Engineers.

†Supt. and Chemist, Sanitary District, Decatur, Ill.

The Decatur problem is being solved by the united efforts of the Board of Trustees of the Decatur Sanitary District, Mr. W. C. Field, President, Mr. Benjamin W. Dillehunt, and Mr. W. M. Wood; its Consulting Engineers, Pearse, Greeley & Hansen; its Construction Engineer, Mr. F. D. Holbrook; its Assistant Chemist, Mr. George Symons, and Mr. R. R. Mills, the author; and through the co-operation of the Staley Manufacturing Company and its consultant, Professor Edward Bartow. Valuable suggestions have also been offered by many others, and the author wishes to acknowledge the services of all these, for without the valuable assistance of the above, the problem would remain unsolved.

above except that from the sprinkling filter. Analyses of the air near the sprinkling filter had the lowest concentration of hydrogen sulfide, but because of the large surface and dilution with pure air it is possible that the total odor from the filters would place it nearer the head of the list. The hydrogen sulfide in the atmosphere about the plant was always far below the concentration for a lethal dose. The digestion gas as collected from the Imhoff tanks with exclusion of air almost always has a lethal dose of hydrogen sulfide (0.5%).

The presence of so much hydrogen sulfide in the Imhoff gases was rather surprising because at normal temperatures Imhoff gas is supposed to be free from hydrogen sulfide. It has been reported in the gases from tanks that were not operating satisfactorily or which had been newly put in service without seeding with old sludge. The quantity of sulfide in the digestion gases at Decatur is a function of the temperature and is shown in Table I and Figure I. These data were collected over a period of six months on the gases from the large experimental collector described later.

Table 1

Sludge Temperature F	Per Cent. Hydrogen Sulfide By Volume	Estimated Pounds Hydrogen Sulfide per day
66.2	0.17	6.
66.9	.30	..
68.0	.31	18.
69.4	.55	39.
69.8	.63	43.
70.9	.56	...
72.0	.61	52.
72.5	.69	..
74.1	.78	66.
74.5	.95	72
75.3	.93	77
76.1	.89	79.
76.6	.92	80.
77.5	.91	..

The pounds of hydrogen sulfide given in Table I are estimated from the analyses and the total volume of gas produced from the tanks. Temperatures higher than 77.5 were not obtained because the tanks were by-passed in April for construction. It is easily seen that the probable hydrogen sulfide production at summer temperatures is above 100 pounds per day which means about 957 cu. ft. per day of pure hydrogen sulfide. This much pure hydrogen sulfide could be detected for considerable distance when atmospheric conditions were calm and favorable.

The heating value and analysis of sewage sludge digestion gases have been known for a long time, but with few exceptions the gases have never been trapped and utilized. Dr. K. Imhoff visited Decatur at just the psychological time when we were talking of collecting the gases, and with his unequaled enthusiasm urged us to immediately put in a large sized experimental trap. He assisted our engineers with many suggestions and in September 1925, the central gas vent on our first Imhoff tank was roofed in under the water level with a sloping wooden structure somewhat resembling the Imhoff collector.* The area covered by this collector represented about one half of the sludge area in the first tank or about one twelfth the total sludge area of all the tanks. In estimating the total gas production from the whole plant we have multiplied the volume from the experimental collector by twelve. This trap was put in service October 15, 1925, and remained in service, except for occasional repairs in the wooden roof, until June 4, 1926, when it was dismantled in order that a permanent concrete collector could be installed. The sewage, however, was by-passed from all tanks April 19, 1926, in order that sludge digestion might come to an end. This was necessary before we could work safely in the gas vents on the complete collecting of digestion gases. Before any men were allowed in the gas vents, analyses of the air were made and the hydrogen sulfide content determined. After one month gas formation was greatly reduced, though still proceeding at the rate of 800 cu. ft. per day, and the hydrogen sulfide content of the air in which the men had to work was less than 0.01 per cent.

The data regularly collected on the experimentally trapt gases were, temperature of sludge digestion, volume of gas produced, hydrogen sulfide content of gas, calorific or heating value of gas and the chemical constituents of the gas. The volume of the gas was found to be dependent on the temperature of sludge digestion, which in Decatur is very favorable to large volume, and to the amount of organic matter settled in the tanks. The relation of temperature to volume is shown in Fig. 2 while the relation of hydrogen sulfide content and temperature is shown on Fig.

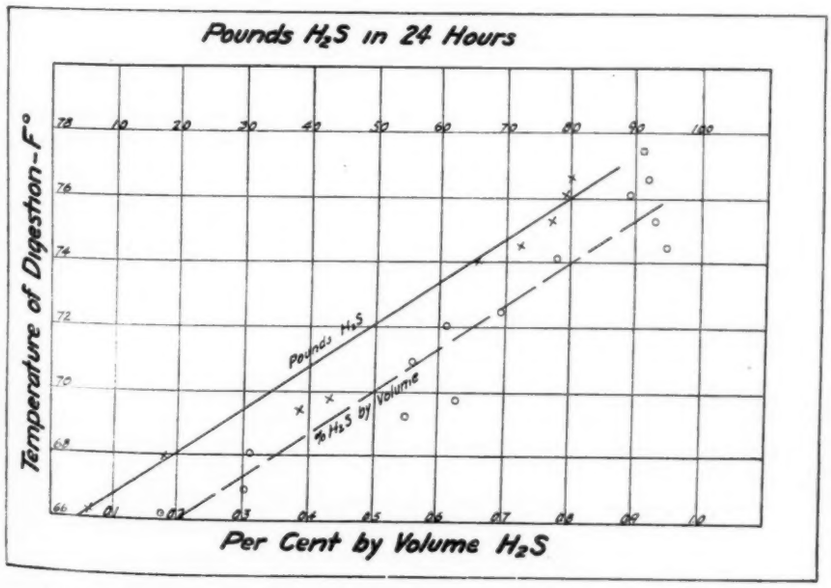


FIG. 1—EFFECT OF TEMPERATURE ON QUANTITY OF SULFIDE IN DIGESTION GASES

*Eng. News Record, Vol. 91, No. 13, p. 512 (1925).

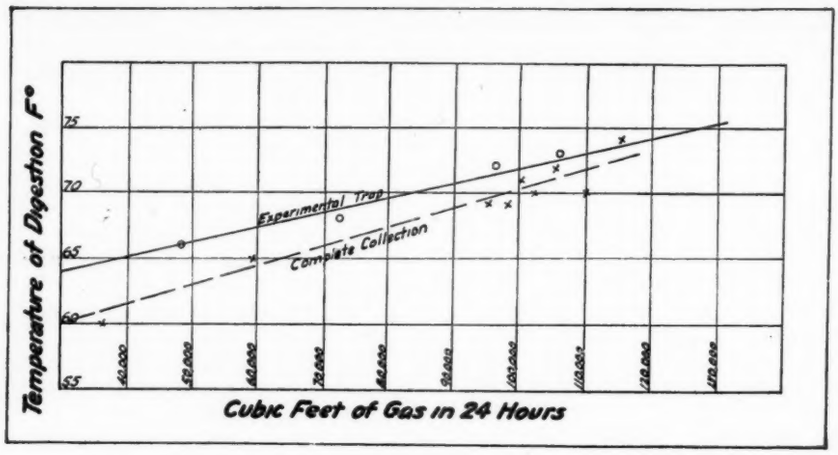


FIG. 2—RELATION OF TEMPERATURE OF GAS TO VOLUME

1. From bottle experiments the volume of gas to be expected under our condition of temperature and sludge may be roughly represented by the following relation: "parts per million suspended matter settled in tanks times million gallons per day of sewage treated times 45 equals the cubic feet of gas per 24 hours," or

p.p.m. S.M.S. x M.D.G. x 45 = c.f. per day.

The trapping of all the gas vents was completed in August, 1926, and sewage turned through the tanks after standing idle for over three months. All the tanks but one started up nicely. This one foamed a little but caused no trouble. The total volume of gas normally obtained varies from 100,000 to 125,000 cubic feet per day with an occasional minimum of 30,000 when the starch works is shut down or when melting snow brings the temperature of sewage to between 50 or 60 degrees. This gas has a calorific value of about 700 B. T. U. per cubic foot. A gas engine manufacturing company has guaranteed that with 700 B. T. U. gas it's engine will develop 1 brake horse power hour per 14 cubic feet of gas consumed. It is easily seen that with 125,000 cubic feet of gas per day we could develop about 8,000 horse power hours or 330 horse power days.

The unusual volume of gas is shown to be dependent on the starch waste. The Staley Company are using every effort to reduce the volume, concentration and temperature of this waste. It is anticipated that within a very few years the starch waste will be no stronger than normal sewage and our gas volume reduced at that time to about 50,000 or less feet per day. Therefore it is not advisable to attempt generation of our own power until we know what our final gas volume will be. The generation of this power, however, is being very carefully studied in conjunction with its use for the new activated sludge plant which is now being built in addition to our present Imhoff tank and sprinkling filter units.

The minute the Imhoff gas was burning, odors about the plant were greatly reduced. As stated above, the suction and deodorizing system had been contemplated. When we realized possibilities of the Imhoff gas, it was decided to build an oven in which the gas could be burned. A suction system with fan was built to force the capped-in sewer gases into the red hot oven and burn them up with the Imhoff tank gases. This has worked very satisfactorily. We can say without question that the odors from the sewer outlet, grit chamber conduit and Imhoff tanks are eliminated. During high water, when the sprinkling filters are not in operation, there is no objectionable odor from the sewage disposal plant. With the sprinkling filters in operation we estimate that the odor has been reduced 75%. The last 25% of odor coming from the operation of the sprinkling filters will, in my opinion, be present until the sewage concentration becomes normal by the reduction of the starch waste.

Size and Material for House Connections

By Alexander Potter*

Eleven municipalities in Essex and Union counties, New Jersey, are about to undertake the construction of a Supplementary Joint Trunk Sewer to relieve a smaller project constructed twenty-five years ago. The capacity of the old structure is 20 million gallons per day; the combined capacity of the old and the supplementary sewer is 100 million gallons per day. In the original sewer there was no central authority over the method or manner of laying laterals or house connections in the various municipalities, and as a result there has been undue leakage throughout many of the local systems.

An investigation and examination of the contributions for the various municipalities indicate that this excessive flow emanates very largely between the street sewers and the houses, due to the fact that these connections have been made in many of the municipalities with terra cotta pipe without strict supervision.

It seems almost academic to point out that unless almost superhuman care is taken in the laying of these sewers, infiltration in excessive amounts is bound to occur. This is due in large part to the perfectly natural desire on the part of house builders to use the sewer not only for cellar drainage but also for the seepage that is bound to occur around all foundations in wet ground. Almost the entire territory is part of a terminal moraine which is thoroughly water-soaked during the major portion of the year.

In attempting to formulate rules and regulations for the construction of these house connections, very

*Consulting Engineer, New York City.

serious consideration is given to the question of continuing the use of vitrified clay or cement pipe in these house connections. It is foolish to assert that vitrified clay pipe cannot be made reasonably water tight, but the fact remains that in water-soaked ground or in ground subject to ground water conditions, in nine cases out of ten tight sewers constructed of material other than cast-iron pipe do not obtain.

The writer, therefore, prepared and had approved by the Joint Meeting rules and regulations making the construction of cast-iron house connections mandatory. It is true that the use of cast-iron pipe increases the cost of sewer construction probably on an average of $7.50 per house connection, but the assurance given that these conditions will be practically water-tight justifies the adoption of cast iron.

Many cases can be cited in which tree roots have been attracted even to small quantities of leakage existing in house connections running across the sidewalks and into the yards, with the result that many of these connections have to be removed periodically because of stoppage due to these tree roots. This difficulty is eliminated by the use of cast-iron pipe.

In the discussion that followed the adoption of this rule, it is of interest to know the reaction of some of the municipalities which have combined to construct the proposed enlarged sewer.

While 4" pipe is adopted as a standard, 5" and 6" pipe is permited in multi-family houses. The city of East Orange, which will be a contributor to the enlarged sewer for about one-sixth of the area of the city, objects to the use of 5" and 6" pipe; the engineer, W. D. Willegerod, a man of wide experience, claiming that even in apartment houses having as many as twenty families, the buildings are served satisfactorily with a single 4" house connection. This is a principle that the writer has advocated for many years, but the theory has not found general acceptance throughout the country.

Another objection raised by the East Orange authorities is to the mandatory use of cast-iron pipe, and the reason for this is that all house connections from the street up to and into the house must by local ordinance be constructed by the city's forces, and they have for many years had a special department doing nothing else than constructing house connections; consequently superior work has been obtained.

The attitude of East Orange raises a very interesting question, and whether a general rule which is fundamentally sound should be varied because one municipality has adopted a very sound practice in connection with the laying of house connections, is open to a free and frank discussion by sanitary engineers.

In regard to the weight of the cast-iron pipe to be used, the shell of the standard cast-iron pipe, in the opinion of the writer, is entirely too light for any permanent use; whereas the extra heavy pipe is unnecessarily heavy and expensive. We have adopted the use of medium weight pipe, which is furnished by many houses but is not listed by most of the houses dealing in plumbing specialties.

The writer would be glad to have these questions discussed freely in the columns of *Public Works*.

Electrical Pumping Equipment for Kansas City

By E. W. Harvey*

Kansas City, Mo., is now completing a new municipal water works plant costing approximately $11,000,000. Raw water from the Missouri river is pumped through the low-lift station to the purification works, through which the water flows by gravity until it reaches the clear water basin under the filters. From the clear water basin it is pumped through tunnels and pipe lines from the secondary pumping station to reservoirs at two high-pressure pumping stations.

There are three new pumping stations known as the low lift, the secondary, and the East Bottoms, the last being a high head station assisting the present high head stations in pumping water directly into the city mains and reservoirs. These three new stations are all electrically operated, being equipped throughout with Westinghouse apparatus.

The low-lift station has four 35 mgd. pumps, one of these being provided with a 20 mgd. impeller. These pumps are driven by 400 h.p. synchronous motors. The station is large enough to house a fifth unit, if necessary. The station is controlled through a 14-panel asbestos switchboard, equipped with mechanical remote control through pull rods and bell cranks. The building is heated by electric radiators which obtain their energy from a transformer applied to the heating circuit.

The secondary station is a duplicate of the low-lift station in its main pumping units, but contains some additional equipment, including three 2,500 g.p.m. wash water pumps, two 500 g.p.m. and two 250 g.p.m. pumps. This station is not electrically heated.

The power for this substation is obtained at 13,200 volts and stepped down to 2,300 volts in an outdoor substation.

*Westinghouse Electric and Manufacturing Co.

EAST BOTTOMS PLANT, KANSAS CITY
Showing two 24 mgd pumps driven by 200 h.p. motors. Six pumps will occupy this station ultimately.

The East Bottoms station has two 24 m.g.d pumps operating against a total head of 380 to 390 feet. Each unit is made up of two single-stage pumps connected in series. These pumps are driven by 2,000 h.p. synchronous motors. The switchboard has 14 panels. Control is an electrical remote type with semi-automatic operation. Ultimately six pumps will be housed in this station.

Water Softening in Columbus

Very important part of treatment. Experiments last year with use of lime, soda ash, and sulfate of alumina or sodium aluminate; also lime-zeolite softening.

The softening of the river water that forms the source of supply for Columbus, O., is perhaps appreciated more highly by the consumers than the removal of bacteria or color. During the 10 years prior to 1926 the hardness of the raw water has averaged 282 parts per million, the lowest yearly average being 265 and the highest 306. The average for 1926, however, was 246, which was reduced by softening to an average of 90.

The unprecedented low total hardness of the raw water during 1926 is attributed by C. B. Hoover, superintendent of the division of water, in his annual report, "in part to the rainfall being slightly above the average, the distribution of the rainfall over the year, and other conditions which caused the run-off to be above the average." Another factor which, no doubt, was effective in reducing the hardness of the raw water was the increased storage provided by the new O'Shaughnessy dam and reservoir. The large volume of soft flood water, which can be stored in this reservoir, no doubt had the effect of flattening out the hardness of the raw water. The value of this storage for this purpose has been estimated at from $30,000 to $40,000 for the past year." (The total operating and maintenance cost of softening and purifying was $239,-164.)

On the other hand, this reservoir is believed to have increased the average turbidity by holding back the flood water, causing the water coming to the plant to be muddier for longer periods of time. The average turbidity last year was 107, while the maximum yearly average for the previous ten years was 102 and the average was 79.

During the year 1926 water softening bottle experiments were run by treating one-gallon samples of river water with lime, soda ash and sulphate of alumina; also with lime, soda ash and sodium aluminate. In one series of experiments liquid sodium aluminate was used and in the other series "Alco Floc" was used. The experiments are being continued, but Mr. Hoover, in his report, gives the following comments and conclusions as preliminary only.

The results show that with the use of aluminum sulfate, or sodium aluminate along with lime and soda ash, the hardness of water such as that treated at Columbus, Ohio, may be satisfactorily reduced to between 35 and 50 parts per million without resorting to excess treatment with lime or soda ash. It is hoped that additional experiments will show that by the addition of a little more soda ash, these same results may be obtained with a smaller amount of coagulant. When sulfate of aluminum is used, additional soda ash must be added to neutralize the sulfate radical but when sodium aluminate or Alco Floc is used, the soda ash requirements are less because these coagulants contain sodium oxide.

It was endeavored to reproduce the results obtained in bottle experiments on a large scale, consequently the entire plant treating 31.7 million gallons per day was operated for three days using 5 grains of alum per gallon and enough soda ash and lime to reduce the hardness to the lowest possible figure.

The character of the raw water treated and the results obtained on the last day of the test are shown in the following tables.

Analysis of river water. Results expressed in parts per million:

Alkalinity	189
Non-carbonate hardness	129
Total hardness	318
Magnesium	27

The treatment was:

Lime	14.5 grains per gallon
Soda ash	10.0 grains per gallon
Sulfate of aluminum.	5.0 grains per gallon

Results of Analysis of softened filtered water:

Hour	12	2	4	6	8	10	12	2	4	6	8	10	Avr.
Total alkalinity	46	47	47	47	45	46	44	48	48	59	59	59	50
Phen. alkalinity	29	30	30	32	20	28	28	28	28	29	32	29	29
Caus, alkalinity	12	13	13	17	11	10	12	7	8	0	5	0	8
Non-carb, hardness	8	5	3	3	11	4	8	9	10	-1	-3	-3	5
Total hardness	54	52	50	50	56	50	52	58	58	58	56	56	55

The plant operating results show that it is possible to produce water at the Columbus plant with a hardness under 60 parts per million, when 5 grains per gallon of alum are used and to do so without using any excess lime or soda ash.

LIME ZEOLITE METHOD OF SOFTENING WATER

During the year 1926, experiments have been made at the Columbus plant on softening Scioto river water by passing it through a zeolite water softener. The results of these experiments indicate that it is cheaper to remove temporary or carbonate hardness from water with lime than it is to remove it by means of the zeolite softening process and that it is not only cheaper but more satisfactory because when temporary or carbonate hardness is removed by the lime treatment, the carbonates are precipitated and removed from the water, thus lowering the total solid content of the softened water which is of course desirable, however, when the temporary or carbonate hardness is reduced by the zeolite process the bi-carbonates of calcium and magnesium are not precipitated and removed from the water, but they are replaced for sodium bi-carbonate and consequently the softened water contains residual sodium bi-carbonate and although the water has been softened, the total solid content has not been reduced.

It has been found that it is possible to remove permanent or non-carbonate hardness (in the Columbus water, calcium and magnesium sulfates) by means of the zeolite process at a cost of about one-half that for removing them by soda ash treatment.

The city of Columbus spent $128,487.58 for soda ash during the year 1925 and if the permanent or non-carbonate hardness can be removed for one-half of this amunt by zeolite, then it means that the operating cost of the Columbus plant could be reduced approximately $64,000 per year by installing and operating zeolite treatment.

The results obtained so far indicate that the days for using soda ash to soften water at large municipal water softening plants are numbered.

Zeolite softening material may be a synthetic product or a natural one. The synthetic product is in composition, a hydrated sodium aluminum silicate and is being manufac-

tured by several reliable companies. Natural or so called green sand zeolite is found in large quantities in the state of New Jersey. Green sand has the appearance of ordinary filter sand except that it has a green color. It can be graded so as to have an effective size of around 0.4 m.m. and a uniformity coefficient of 1.60 which is standard grading for filter sand. It has, like the artificial zeolite, the property of being able to exchange its base, sodium, for the calcium and magnesium in the water that is brought into contact with it. Hard water may be softened to zero hardness by simply filtering it through a bed of zeolite material. The calcium and magnesium salts in the water are not precipitated as in the lime soda ash method but are replaced or exchanged, as has already been indicated, by the sodium from the zeolite. In other words, calcium and magnesium are the mineral salts which in solution in water cause it to be hard and when they are replaced by sodium, the water is soft.

When the zeolite has exchanged its sodium for calcium and magnesium it becomes inert and must be regenerated and this is done by passing a solution of common salt (sodium chloride) through the material. Thus the sodium from the sodium chloride washes out or replaces the calcium and magnesium taken from the water and reconverts the zeolite back to its original condition.

One cubic foot of green sand will remove 3,000 grains of hardness before being exhausted and according to the results obtained at McKees Rocks, Pa., 0.315 pounds of salt are required for each 1,000 grains of hardness removed. Salt at McKees Rocks costs $6.75 per ton delivered. Based on McKees Rocks' figures the salt cost of removing one part per million hardness per million gallons equals $0.062. During the year 1925 the average cost of lime for removing one part of carbonate hardness per million gallons was $0.057, and the average cost of soda ash for removing one part per million of permanent or non-carbonate hardness per million gallons was $0.126. These figures show that the cost for salt for softening water through zeolite is only about one-half the cost of soda ash for removing non-carbonate hardness. In addition to the salt cost, an extra allowance should be made for wash water when using the zeolite method for about 10% wash water is wasted in this process.

The zeolite process offers several advantages over the soda ash treatment in addition to the one of cost and they are as follows: 1st. The complications of reaction referred to in the first paragraph of this report and explained in detail in last year's report are eliminated. 2nd. Water of any degree hardness may be obtained and this is not possible to accomplish with the lime soda ash process.

It is now planned to take the filter sand out of one of our mechanical filters and replace it with zeolite sand. The operation of this one filter will be regarded as an experiment and the results obtained from its operation will very probably determine whether or not more of the filters will be converted into zeolite softeners.

The process of operating a lime zeolite softening plant would be about as follows: The water pumped into the plant would be first treated with lime and alum, mixed in the mixing tanks and then passed through the settling basins, just the same as it does now to remove the precipitated carbonates. At the end of the settling basins, the lime softened water would be carbonated with CO_2 gas in order to convert the normal carbonates to bi-carbonates, thus preventing the deposition of normal carbonates on the zeolite sand and to prevent the formation of normal sodium carbonate in the softened water. From the settling basins the water would flow to the filters and if desirable to reduce the water to zero hardness all of the water would be passed through zeolite filters. If it was desirable to leave some residual hardness in the water, then of course it would only be necessary to filter a portion of the water through zeolite filters.

At the Columbus plant it is believed that it will be possible to reduce the hardness of the water to 160 parts per million with the lime treatment alone and that in order to produce a softened water with a total hardness of say 80 parts per million, it will be necessary to filter only half of it through zeolite filters, reducing the hardness of the half portion to zero, and then mixing it with the other half portion having a hardness of 160 parts per million, giving a resultant product with a hardness of 80 parts per million.

CARBONATION

Plans and specifications have been completed for the carbonation plant and the contract for its construction will very probably be awarded early in February. The gas making plant will consist of six principal parts: a gas producer, a gas burner, a return tubular boiler, a steam driven air compressor, a combination scrubber and dryer and a diffuser.

In operation, coke is burned in the gas producer, which is a closed furnace with controlled air supply furnished by a blower. The products of combustion pass from the gas producer to a gas burner where they are mixed with air and burned to complete combustion under a boiler. The steam produced in the boiler will be used to drive the air compressor and blower so as to make a closed cycle for the process. The air compressor will take its suction from the boiler stack through a scrubber and dryer and force the washed gases through diffusers into the water to be carbonated.

Salable Refuse

Describing, before the International Association of Street Sanitation officials, the work of rubbish and ash collection in Highland Park, Michigan, M. H. Zink, superintendent of public service, stated that they found themselves at a loss for a place to dispose of the metal, glass, etc., in the rubbish. The city purchased a small baler from the Economy Baler Company of Ann Arbor, and built a rubbish burner to take care of paper, brush, etc., and then got in touch with several foundries with regard to disposing of tin cans. Finally it sold them to a Buffalo firm at $7.00 per ton, f.o.b. Buffalo, the freight rate being $3.68. Two years later arrangements were made whereby all the metal is sold in Detroit, f.o.b. Highland Park. Early this year the city was receiving the following prices for these materials: Tin cans, wire and miscellaneous scrap, $5.00 per ton. Auto bodies and fenders, cut into busheling, $8.20 per ton. Auto frames, axles, gears, $10.50 per ton. Cast iron, $12.50 per ton. Hot water tanks, $4.50 per ton. All f.o.b. the yard at Highland Park. The sale of scrap during the last fiscal year amounted to $2,945. Mr. Zink said, "I would not recommend that cities of from 5,000 to 15,000 population put in a salvaging system, as it would not pay them."

Snow Removal in Maine

In snow removal work in Maine during the winter of 1925 and 1926, the following schedule of rental charges for equipment was adopted, rental to include gasoline and oil: Holt 10-ton tractors, $5 per hour; F. W. D. 3-ton trucks, $2 per hour; Nash Quad 3-ton trucks, $2 per hour. No rental charge was figured on snow plows, several of which were loaned by the manufacturers to the State Highway Commission on a demonstration basis. Drivers and helpers were paid at their regular per hour wage, with no extra pay for overtime work, but were allowed the cost of food purchased when out on the work. Trucks and tractors were supplied by the Department of Agriculture from surplus army equipment.

The road from Augusta to Gardiner was kept open at a total cost of $335.59, a cost per mile of $55.93. First plowing was done February 4. This road is subject to bad drifting in only one place.

From Augusta to Winslow, 17 miles the road is exposed and subject to drifting. Work began early in January. The total cost was $2,282.61, or $126.78 per mile.

For clearing the road from Winthrop to Augusta, 11 miles, the cost was $1,495.23—$135.94 per mile.

Experience showed that the rental fees of $2 per hour for trucks and $5.00 per hour for tractors was not sufficient to cover the cost of keeping the equipment in repair and the purchase of gasoline and oil. The costs of the work indicate that the rental charge should have been nearly 50% higher.

Experiences in snow removal in the sections around Biddeford and Saco indicate that the proper use of snow fences will reduce the necessary plowing by nearly 50 per cent, and that the cost per mile of keeping the roads open throughout the winter is very little greater than the cost of clearing them in the spring after the snow has been packed and frozen during the winter. A great deal of the work of keeping the roads open can be accomplished by trucks with light plows using tractors for heavy work and for throwing back the banks along the sides.

Results From Passaic Valley Sewer

Increase in Percentage Saturation of Dissolved Oxygen in the Passaic River and Newark Bay and Effect Upon New York Bay. All Trade Waste Not Yet Diverted From River. Pumping Plants and Treatment Plant.

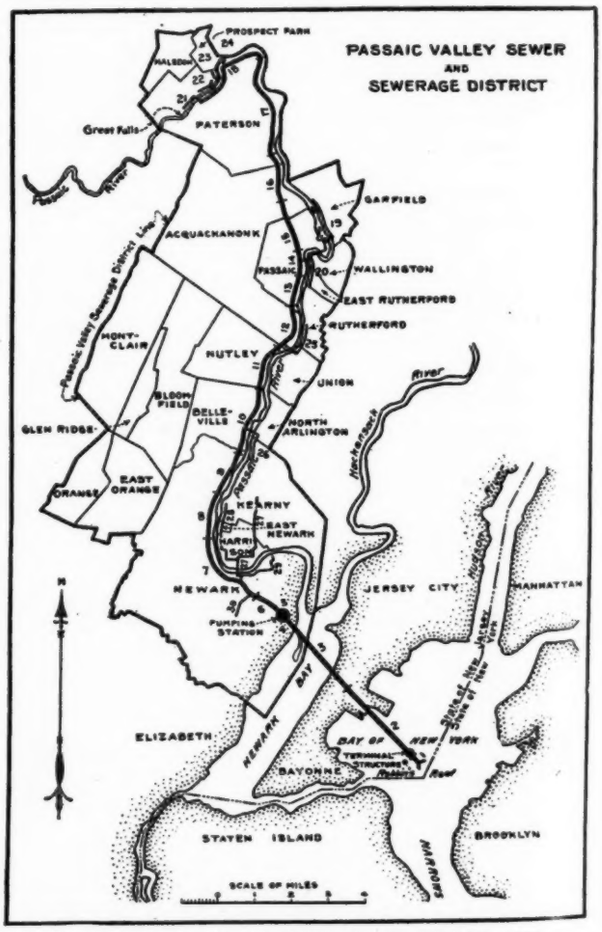
The Passaic Valley intercepting sewer and sewage treatment plant went into operation on August 2nd, 1924. Since that date the Passaic Valley Sewerage Commission has been working physically, through persuasion, and by legal action to secure the fullest benefit to the communities in the Passaic Valley for the more than twenty million dollars spent in constructing this sewer. This commission has recently made public a report reviewing briefly the history of the construction of the system and stating in various terms the results which have followed the operation of it and the problems which remain to be solved before the full effect and benefit can be realized.

The improvement effected upon the Passaic river by the operation of the Passaic Valley sewerage system has been expressed by the commission in terms of per cent. saturation of dissolved oxygen of the river water; while its effect upon New York Bay and the adjoining waters due to the discharge of the sewage into them is also indicated by per cent. saturation of oxygen.

The improvement in condition of the river has not been as much as had been hoped even by engineers and sanitarians familiar with conditions and with possibilities and results which might be anticipated from the operation of the intercepting sewer. Per cent. saturation of dissolved oxygen in the Passaic river through Newark still averages below 25; but this is an increase from an average of about 14 during the first year after the system went into operation. The commission in its report says: "While the increased saturation of oxygen in the river is not spectacular it is very promising. It must be remembered that many odds and ends of pollution have still to be eliminated. The oxygen saturation of the river water as we receive it at the Falls (at Paterson, the upper end of the sewer) is nothing to boast about, and from Paterson down there are several sources of pollution which are at present in various stages of being eliminated."

One feature which is referred to is that the condition of the river above the Falls at Paterson is deteriorating. Unfortunately the commission has no authority over the river above this point.

Probably the most difficult problem now facing the commission is the elimination of pollution by industrial wastes. The magnitude of this problem is not sufficiently realized and appreciated by legislators



OUTLINE MAP OF SEWERAGE DISTRICT AND INTERCEPTING SEWERS

and administrators. Neither is the burden placed on many individual manufacturers duly recognized. In order to avoid discharging waste into the river it is necessary for many of these plants to make large initial investments in the way of alterations and installation of plant, and in many cases to increase the cost of chemicals for treatment and labor for operation of the plant. Although the elimination or abatement of industrial pollution is not yet by any means complete, considerable progress has been made. But each individual case is a problem to be considered separately, some of them being quite intricate, and progress will necessarily be slow. Four hundred and twenty-two industrial plants contributed more or less to pollution of the river, and of these, 361 have eliminated or abated pollution, 41 are still polluting the river, and 20 are under investigation.

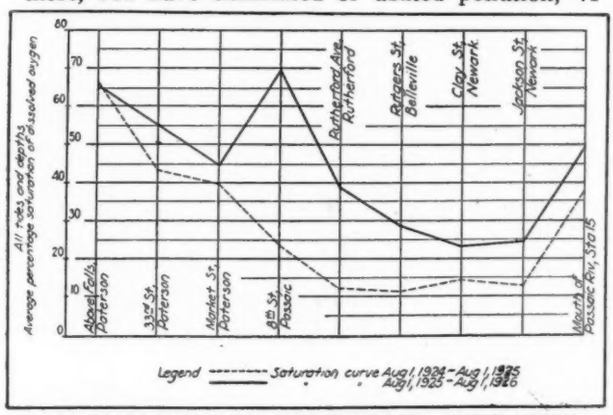

Average percentage saturation of dissolved oxygen
All riots and depths
Above Falls Paterson
31st St. Paterson
Market St. Paterson
8th St. Passaic
Rutherford Ave. Rutherford
Rutgers St. Belleville
Clay St. Newark
Jackson St. Newark
Mouth of Passaic Riv. Sta 15
Legend ---------- Saturation curve Aug 1, 1924 - Aug 1, 1925
Aug 1, 1925 - Aug 1, 1926

DIAGRAM SHOWING PERCENTAGE SATURATION OF DISSOLVED OXYGEN IN PASSAIC RIVER AT VARIOUS POINTS, FOR TWO YEARS

The accompanying diagram shows percentage saturation of oxygen in the Passaic river at various points for the first two years following the use of the intercepting sewer. Unfortunately no analyses are available of conditions before that time. These curves have been constructed from a number of analyses taken at all tides and depths of the river. The considerable jump indicated at the Eighth Street bridge in Passaic is undoubtedly due to re-oxygenation of the water in the falling over a dam at that point. Below this point the oxygen is gradually depleted until, at Clay street and Jackson street, Newark, it reaches its lowest level. During the hot weather of summer the oxygen conditions are still less favorable, and fall below 12 per cent. dissolved oxygen at Belleville and Newark.

Diverting sewage from the river into the intercepting sewers had also the effect of decreasing the flow of the river and thus reducing the dilution available for such pollution as still enters it. Moreover, increasing the flow in the local sewers, especially in the city of Paterson, has resulted in frequent overflowing from the sewers into the river, this overflow taking with it some of the domestic sewage which formerly was confined to the sewer system. Also too many plants have connected up all their wastes, most of these being comparatively clear wash water which should be parted from the polluting wastes and turned into the river.

Undoubtedly a considerable part of the remaining pollution of the river at its lower reaches is due to

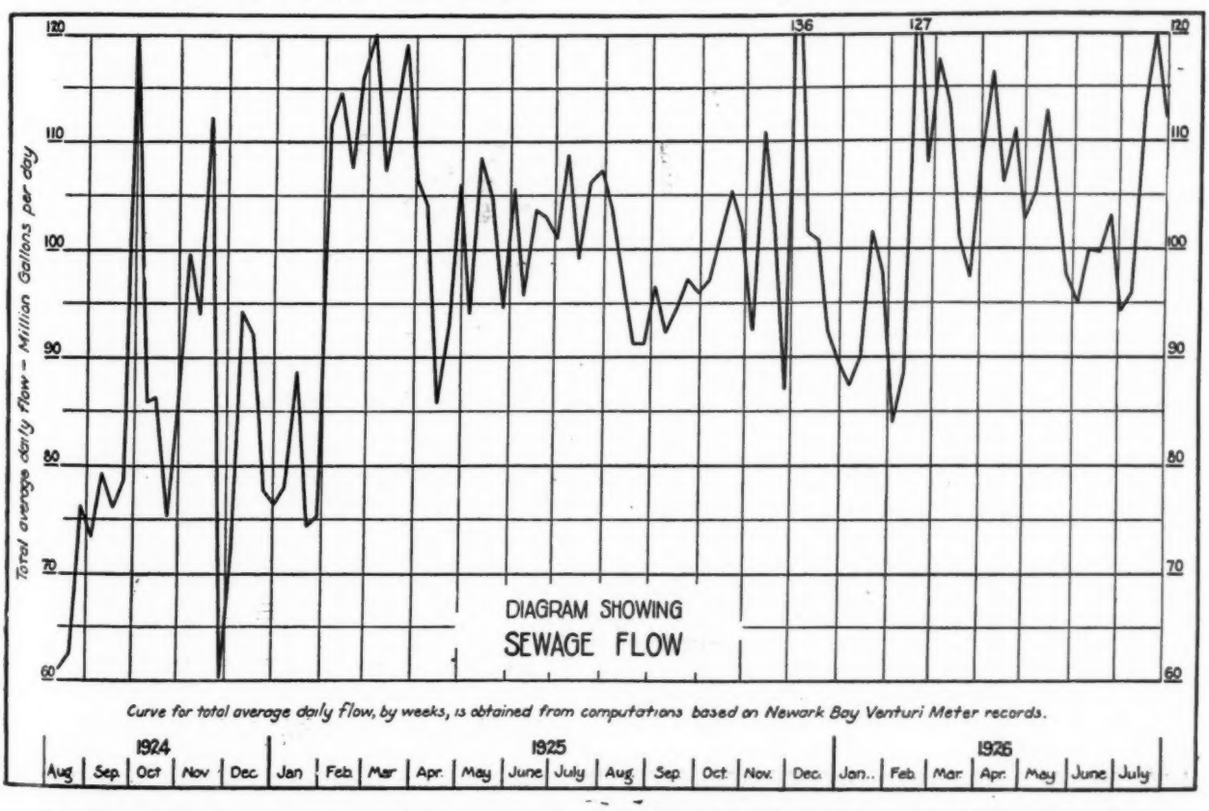

Total average daily flow - Million Gallons per day
136
127
DIAGRAM SHOWING
SEWAGE FLOW
Curve for total average daily flow, by weeks, is obtained from computations based on Newark Bay Venturi Meter records.
1924
1925
1926
Aug Sep Oct Nov Dec Jan Feb Mar Apr May June July Aug Sep Oct Nov Dec Jan Feb Mar Apr May June July

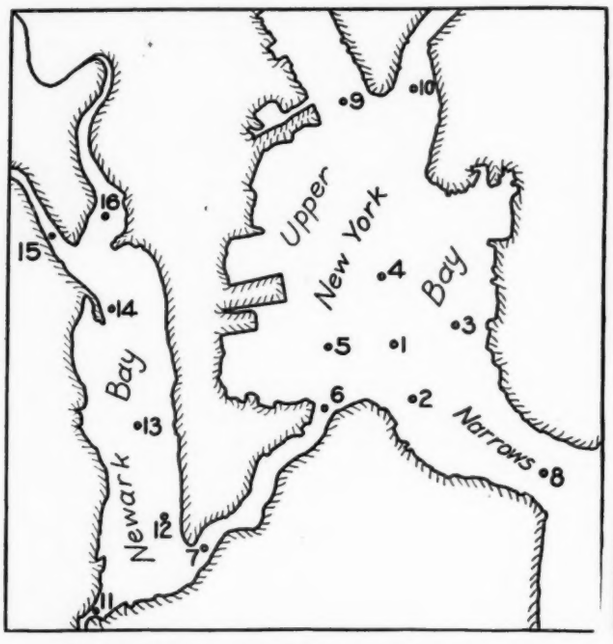
DIAGRAM SHOWING TOTAL SEWAGE FLOW OF THE DISTRICT BY WEEKS IN MILLION GALLONS A DAY FOR THE FIRST TWO OPERATING YEARS

the gradual putrefaction going on in the deposits of sludge which have been accumulating for years in the bed of the river. These will gradually work themselves out, but it will probably be years before they will cease contributing objectionable gases and solid matter carried up by gases into the stream flowing above.

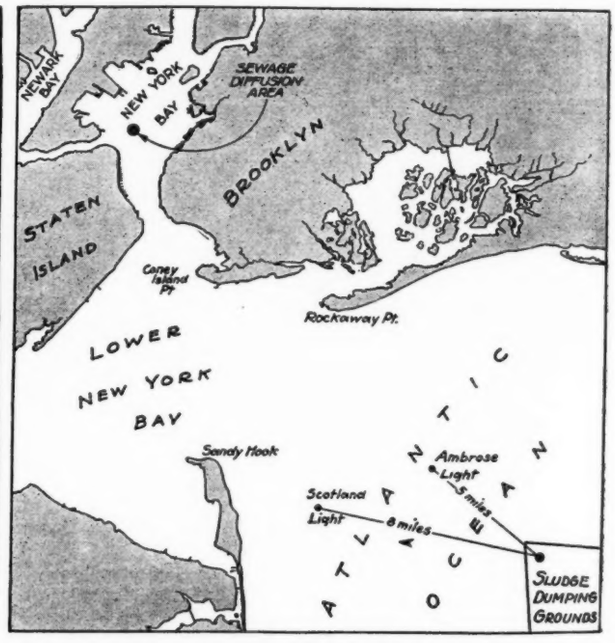
Not less important than the clearing up of the Passaic river is the improvement of conditions in Newark bay. This bay had reached the point where it could not satisfactorily assimilate this waste, and in the summer prior to the opening of the sewer, many samples of water were obtained which were entirely devoid of oxygen in solution. At station 7 (see the accompanying map) the improvement is not very marked, owing probably to the increasing sewage pollution in Arthur Kill. But in the bay the foul odors have disappeared and at the mouth of the Passaic river the percentage saturation of dissolved oxygen has increased from 25 per cent. to nearly 50 per cent. in two years. The accompanying diagram shows the percentage saturation of oxygen at various points in the Newark bay for three years.

In consenting to the discharge of sewage from the Passaic valley into New York Harbor, the Federal Government stipulated for "the absence of reduction in the dissolved oxygen contents of the waters of New York Bay, resulting from the discharge of Passaic Valley sewage to such an extent as to interfere with major fish life."

The Government also stipulated that there should never be any visible particles in suspension due to this sewage; that there should be practical absence of sewage odors in the diffusion area and of color or grease attributable to Passaic Valley sewage. With a view to furnishing evidence on this point, the com-



MAP SHOWING SAMPLING STATIONS IN NEW YORK AND NEWARK BAYS



MAP SHOWING LOCATION OF SEWAGE DIFFUSION AREA AND SLUDGE DUMPING GROUNDS

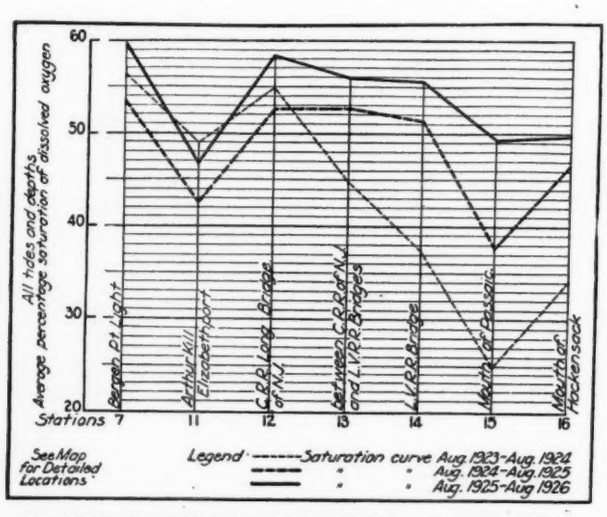


DIAGRAM SHOWING PERCENTAGE SATURATION OF DISSOLVED OXYGEN AT VARIOUS POINTS IN NEWARK BAY FOR THREE YEARS

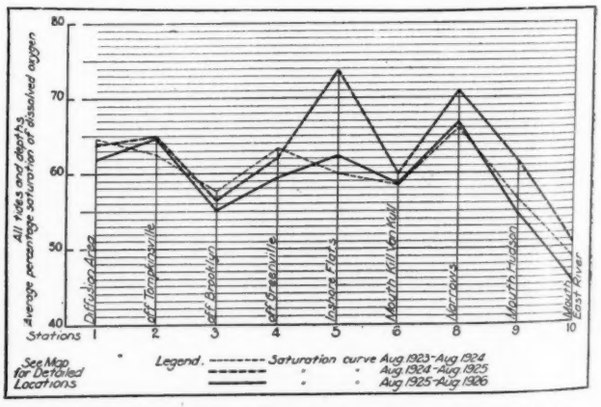


DIAGRAM SHOWING PERCENTAGE SATURATION OF DISSOLVED OXYGEN AT VARIOUS POINTS IN NEW YORK BAY FOR THREE YEARS

mission began, just a year previous to the date of the trunk sewer going into operation, taking samples regularly at selected points in New York bay as well as in Newark bay. The points selected for

sampling are shown on the accompanying map. Sampling at these points has continued regularly except for occasional short periods when there was so much floating ice as to make trips to the point dangerous.

Reporting on these points, the commission says: "It does not appeaar that the discharge of the Passaic Valley sewage has, during the two years of operation, lowered the dissolved oxygen content of the whole upper New York Bay. Our oxygen determinations shows such small and inconsiderable depletions due to the discharge of Passaic Valley sewage that we have completely lived up to the terms of this stipulation regarding dissolved oxygen."

The commission also states that there have never been any visible particles in suspension attributable to the Passaic Valley sewage; that there has been practical absence of sewage odors; and that there has never been any grease. At times of slack water during the past year there have been observed more or less frequently patches of color which persist more or less until the tide has turned, when they disappear. The color is so faint, however, that on only one occasion was it possible to obtain a bottle sample in which the color could be detected. The commission believes, therefore, that this may be construed as "practical absence" as called for by the stipulation.

MAINTENANCE AND OPERATION

In another chapter of the report the commission gives details concerning the maintenance and operation of the system, following a brief description of the system itself.

The system consists of 21.66 miles of main intercepting sewer varying in size from 3 feet 9 inches to 12 feet 9 inches; 5.08 miles of outfall pressure sewer from 11 feet to 13 feet 10 inches in diameter; 13.95 miles of branch intercepting sewers, of which 0.69 mile is included in river crossings; and 1,500 feet of distributing pipes and 764 feet of diffusion pipes in connection with the outfall pressure sewer.

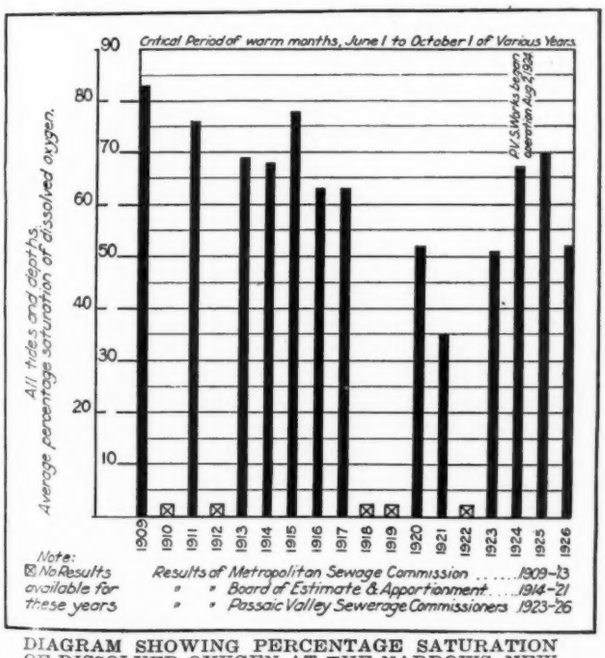
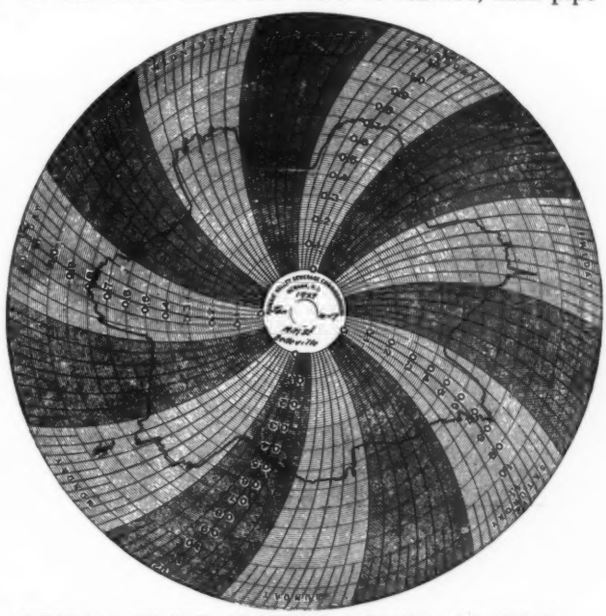

Critical Period of warm months, June 1 to October 1 of Various Years
All tides and depths
Average percentage saturation of dissolved oxygen.
90
80
70
60
50
40
30
20
10
P.V.S. Works began operation Aug. 3, 1924
1909 1910 1911 1912 1913 1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926
Note:
☒ No Results available for these years
Results of Metropolitan Sewage Commission 1909-13
" " Board of Estimate & Apportionment 1914-21
" " Passaic Valley Sewerage Commissioners 1923-26

DIAGRAM SHOWING PERCENTAGE SATURATION OF DISSOLVED OXYGEN AT THE NARROWS, NEW YORK BAY OVER A PERIOD OF EIGHTEEN YEARS

This outfall sewer ends in a terminal chamber in New York Bay, from which two pipe lines 50 feet apart lead straight out into the bay to the diffusion area in the deep water of the main ship channel. Each pipe line is 8 feet diameter and consists of heavily reinforced concrete pipes having tapered hub and spigot joints. They are laid in dredged trenches and supported on blocking and pile foundations. At the outer end of each pipe line, where a depth of 40 feet below mean low water is reached, each pipe



TYPICAL CHART SHOWING RECORD OF HEAD ON MILL ST., BELLEVILLE WEIR PLATE FOR THE WEEK OF JAN. 10-17

is branched three times into pipes having an additional length of 764 feet and diameters varying from 8 feet to 2 feet 8 inches; and from these six branches, covering an area of 3.5 acres, the sewage is discharged through 150 separate nozzles into the waters of New York Bay.

To connect the sewer systems on the left bank of the river with the intercepting sewer which is on the right bank, it was necessary to construct nine river crossings. Eight of these are of cast iron varying in diameter from 16 inches to 42 inches; four laid by the cofferdam method and four by dredging. In addition to which there was a 48-inch plain concrete crossing built in compressed air tunnel.

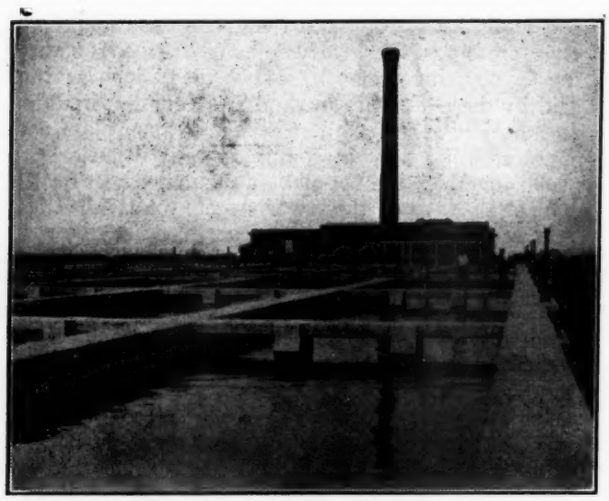
All together, the population, estimated as of 1926, which is served by the sewer system totals 1,041,000, spread over an area of 49,307 acres.

At two points the territory was too low to drain to the intercepting sewer by gravity and pumping stations were necessary, these being known as the Yantacaw and the Wallington. The Wallington station was origianlly designed for steam-driven pumping units but at the time the machinery was installed alternatives were received on both steam and electric equipment and it was demonstrated that the latter was cheaper both in first cost and in operation and it was therefore adopted. Power for the operation of the station in purchased from the Public

Service Electric Company. Two of the three pumping units are equipped with emergency gasoline engines and during the two and a half years of operation the emergency equipment has been needed only once when, July 15, 1925, the electric service was interrupted for 14½ hours due to trouble with the electric cable crossing the river.

The Yantacaw pumping station was designed, built and equipped to operate by electric power and has given very little or no trouble from mechanical difficulties. This station also is equipped with an emergency power unit in the form of a gasoline driven generator capable of operating the full capacity of the station and during the two and a half years of operation it has been used on several occasions when difficulties have been encountered with the transformers.

On the Newark meadows is located a sewage treatment plant which clarifies all of the sewage delivered by the intercepting sewer. Here is a pumping station which raises the sewage about 37 feet into the adjacent sedimentation basins, from which it flows by gravity through the outfall pressure tunnel into the dispersion system. Before reaching the pumps the sewage passes through coarse screens, a grit chamber, and fine screens. At this station there are three triple-expansion horizontal Corliss engines with 17-inch, 28-inch and 50-inch steam cylinders respectively, with 42-inch stroke, each driving a 140-inch impeller in a centrifugal pump with 60-inch suction and 60-inch discharge. During the two and a half years of operation all three of the 140-inch impellers on the main pumping units have cracked and have been replaced by new ones of heavier design. The main thrust bearing on each unit has failed under the tremendous load it carries and has been replaced by a bearing of somewhat different design. Steady bearings are now being installed on each unit directly above the pump casing to prevent the lateral motion which is threatening the safe operation of the units. Serious trouble was encountered with the condensing system due to the fact that sewage is used for condensing purposes, and this, although it is screened before it passes through the condensers, sometimes contains rags and other matter which blocks the condensers. This difficulty has been partially overcome by taking the condensing water from the discharge sewer instead of the suction sewer and screening it a second time. Eventually condensing water will be brought from Newark bay about 3,000 feet away. The foot-pounds of work per pound of steam at this plant during the two years has varied from 32,081 to 60,478. The cost per million gallons pumped averaged $5.92 in 1925 and $5.87 in 1926; this including wages, coal, cylinder oil, engine oil, water and miscellaneous, wages accounting for about 65 per cent. of the total and coal about 25 per cent.



SEDIMENTATION BASINS AND NEWARK BAY PUMPING STATION

The sewage from these pumps passes through twin 96-inch discharge sewers to the Venturi meter chamber and, passing through the meter, flows directly to sedimentation basins which are 550 by 220 feet, divided into four units, each unit with three compartments and each compartment having 9 sludge hoppers.

A force of three men under a foreman skims the basins, washes them down, removes the debris which collects in the inlet conduits and attends to the opening and closing of valves for drawing off the sludge. Each sludge hopper is connected to a 20-inch sludge main which extends to the water front 2,000 feet distant, where it is discharged into barges.

The barges are towed out to the disposal area at sea designated by the Federal Government and located five miles southeast of Ambrose Lightship and eight miles southeast of Scotland Light. The amount of sludge discharged at sea averages 3,000 tons per week in the winter, spring and fall months and 5,000 tons per week during the hot weather. This work is now being done under yearly contract at the rate of 34 cents per ton of sludge.

Instructions for Topographic Surveys

The Geological Survey, Department of the Interior, has just issued four parts of a bulletin describing in detail, standard methods adopted by the Geological Survey for triangulation, leveling, running traverse lines, and computing map positions.

Part A treats of administrative matters only and is of principal interest to officers and employees of the topographic branch of the Geological Survey. Parts B, C, and D describe the methods adopted by the Geological Survey, after its 40 years' experience, as those best suited for obtaining accurate control for topographic maps on any scale.

Bulletin 788-B, which relates to triangulation, gives forms and examples for keeping field notes and for the computation of final geographic position; each step in the process is explained at length. The Geological Survey's work in triangulation has a limiting error of 1 part in 5,000 of computed distances.

Bulletin 788-C describes in great detail the most approved methods for running traverse lines and computing map positions. Under present conditions of field work the Geological Survey covers greater areas by traverse control than by triangulation. Directions for determining true azimuths from observations on the sun or on Polaris are given in such detail that any engineer who will follow them can

make the observation and compute the azimuths without difficulty.

Bulletin 788-D covers leveling, a branch of the topographic work in which accuracy is highly essential. The instructions in Part D are the result of years of experience in spirit leveling. They describe methods of work which if followed strictly are as nearly "fool proof" as human endeavor can expect. The spirit leveling as carried on by the Geological Survey cannot be classed as "precise" but it is of a much higher grade than that done by engineers of public works generally. The allowable limit of error for Geological Survey lines is 0.05 foot multiplied by the square root of the length of the line in miles. For a 10-mile line the permissable error would be less than 2 inches; for a 50-mile line, 4¼ inches. Bulletin 788-D illustrates the types of lettered metal marks used and tells how they are to be set. It prescribes the size and shape for the concrete piers and the proportions of cement, sand, and stone to use in making them. Eventually the elevation to the nearest foot will be stamped on each standard bench mark, but until this is done field engineers are advised to apply to the office of the Geological Survey for the latest determinations. The book illustrates the instruments used and tells how to adjust them and to make simple repairs—for example, how to insert new cross wires or to replace broken level vials. It is intended that every important item necessary to bring successful results may be found in the 44 pages of this bulletin.

The free edition of Parts B, C, and D of Bulletin 788 is small, but these three reports may be purchased from the Superintendent of Documents, Washington, D. C., at 10 cents each.

Cement Factor*

By D. V. Terrell†

Cement factor—that is, the number of barrels of cement used per cubic yard of concrete—has been a greater source of worry to paving contractors than any other single item. In making his calculations for the amount of cement to be used, the contractor usually employs some arbitrary factor taken from tables or cards intended for general use in estimating. The usual result is that, in actual operation, he finds an overrun or shortage of forty to one hundred bags of cement a day.

The cement factor in use in highway work in Kentucky is determined by the testing laboratory from the aggregates to be used and the mix specified. This factor is worked out for each two miles of pavement or whenever there is any noticeable change in the aggregate. The proportioning of the cement, fine and coarse aggregate must be done by volume, and as specified.

Since all of the material must be measured by volume, and that amount is fixed, it is impossible to determine exactly what the cement factor will be, because it will change slightly with different gradations of the aggregate. However, checks of construction work during the 1926 season showed the laboratory calculations to correspond fairly closely with actual conditions in the field. As a rule, a cement factor of about 1.50 to 1.55 may be expected with a 1:2:3.5 mix when gravel is used, and 1.60 to 1.65 when crushed stone is used.

Field checks will usually run higher, for the contractor, in order to maintain a road thickness of 6 inches, must run 6 to 6¼ inches, averaging 6⅛ inches. By this increase in thickness, the apparent cement factor is increased by about 2 per cent. Thus, if the laboratory estimate shows 1.52 for gravel aggregate, the contractor must estimate on the basis of about 1.55; and where the laboratory finds 1.62, as for crushed stone, the field requirements will be about 1.65.

Low subgrade plays a very important part in the matter of overrun. The contractor may work his subgrade as near 6 inches as possible, but he cannot afford to allow thin pavement to go in, thereby saving a few bags of cement, for the penalty for thin pavement would be much more than the saving in cement. For instance, on one mile of pavement with an average thickness of 5⅞ inches, the cement saving would be $200, and the penalty $1,000.

The contractor must keep his pavement consistently at or above the required depth, and by so doing his cement factor will increase 2 per cent. or more, depending upon the extra thickness. It therefore seems advisable to figure it high enough to take care of the probable excess due to the extra thickness necessary.

* Abstracted from *"The Scraper,"* Kentucky Association of Highway Contractors.

† Engineer of Tests, State Highway Department of Kentucky.

Revenues from Automobile Registration and Gasoline Tax

According to figures published by the Bureau of Public Roads the total number of motor vehicles registered last year was 22,001,393, which was more than double the registration for 1921. Of last year's total, 2,764,222 were motor trucks and road tractors, and 19,237,171 passenger automobiles, taxis and buses.

Registration fees from the motor vehicles totaled $288,282,352, of which $16,602,211 was used for collection and administration, $191,111,302 for state highways, $51,702,184 for local roads, $25,274,158 for state and county road bonds, $865,240 for street paving in Baltimore and Washington, $2,727,120 for New York City general fund, and $137 unstated.

Galosline taxes collected during the year totaled $187,603,231, of which $238,897 was used for collection costs, $129,441,520 for constructing and maintaining state highway and $43,609,479 for local roads, $5,238,869 for road bond payments, $5,450,644 for paving and repairing the streets, $103,225 for a sea wall to protect a highway, $1,306,721 for Texas school fund, and $2,213,876 for state general treasury funds.

Briefly, combining fees and taxes, there was collected $475,885,583; of which 3 1/3% was used for collection costs, 67 1/3% for state highways; 20% for local roads; 8% for road bonds, city pavements or other highway purposes, and only 1 1/3% for purposes other than highway.

These figures show that about 40% of all the money spent last year on highways by states, counties, towns or others came directly from the pockets of automobile users as such in the form of registration fees and gasoline taxes.

Aerial Maps for Highway Planning*

Mapping Erie county, New York, using aerial photographs, with ground controls based on previously surveyed traverses, and an agreement between the two within one percent on a scale of six hundred feet to one inch

In the last decade aerial photography has developed until it has become an almost essential adjunct to the solution of many engineering problems having to do with large areas. Particularly in planning new traffic arteries and allied improvements near large cities, accurate aerial surveys are invaluable.

During pioneer days in the far west there were a certain few individuals who gained reputations as guides because of their undoubted skill as pathfinders in the foothills and mountains. In later years some of them disclosed the means by which they were able to find the best way through uncharted country. It was by making a visual survey of the country from the top of the highest available ground, and noting the course of the principal valley or stream and location of high peaks and intersecting valleys. This picture stored in a retentive mind was the early version of the modern aerial picture.

The aerial survey and map which is being made of Erie County, New York, is primarily for the purpose of a general study of the Greater Motorways System and the preliminary ground location of the various roads comprising the system. The survey was authorized by the Board of Supervisiors and is being made under the direction of the county engineer.

For the purpose of an aerial survey, ground controls are necessary, together with a skillful pilot and photographer. To bring photographs to scale they must be taken from a fixed height. Both the plane and the camera must be especially adapted to this use. The photographs are taken vertically from a high altitude, with an overlap which is eliminated when they have been accurately scaled, and built up into a mosaic picture of the terrain included. Previously surveyed lines or traverses across the region may be used for control.

The flying and photography was done at an elevation of 9,600 feet and the finished map is 600 feet to the inch. With few exceptions the control points are two miles, or less, distant from each other. Traverses of existing roads were used for the control. Most of these roads had been surveyed for existing highway improvements and the notes of these surveys were used in platting the control. Nevertheless it was necessary to run many miles of new traverse.

Too much time or money, however, should not be spent on undue refinement for accuracy. This is controlled, though, by the accuracy required of the completed map. The platting of a control map in the ordinary drafting room, to cover 170 square miles of territory on a scale of 8.8 inches to the mile, is quite a labor. The sheets are large and difficult to handle and to retrace the work for the purpose of closing an error in traverse may be time wasted. In attempting to close traverses several miles in length it is readily seen that a failure to close, when the error is less than one per cent., is for all practical purposes accurate enough.

The map was made on the basis of a variation of not to exceed one per cent. between the control map and the aerial map with points on the former not over two miles apart. In other words, the aerial map was required to agree with the control map within .088 inch, scaling each way from central points two miles apart.

For the purpose of general study and planning it is at once apparent how trivial one or even two per cent. in variation of map distances becomes when the errors are not cumulative and when such error does not exceed 1/10 or even 1/5 inch in open country. Where the control points can be closer together, as in street areas, this error can be reduced to 1/100 of an inch on a 600-foot block, closer than a draftsman can plot it.

The map of Erie County is being furnished in atlas sheets covering an area of 2½ miles east and west and 1½ miles north and south between border lines. This produces sheets 17 by 27½ inches, including binder edges. It also is printed in maps covering about sixty square miles each. The former are for use in the field and office, and the latter for office use only.

Aid in laying out preliminary lines is only one function of an aerial map. In country similar to that around Buffalo the ability to show a property owner where the line is located, and why it is so located, is of more value than the mere location of the line. For these reasons the securing of rights of way becomes one of the most important uses of aerial maps.

Another important use is in legal disputes involving property lines and accidents on public property. In the past summer a serious accident happened near a town park and suit for damages was brought against the town board. Testimony was given, by both sides, that the accident happened at or adjacent to a certain depression. The county engineer had furnished the town with an enlarged aerial map of the locality in question. This map was entered as evidence, the depression located thereon and shown to be off the property owned by the town. The plaintiff lost.

Any engineer or board, working on a general planning scheme, will readily realize how their work can be hampered by conflicting opinions arising from a general distribution of the survey maps before the plans are perfected. Therefore, the advantage of curtailing such distribution is apparent.

It is not meant by this that no one but the officials directly responsible can have access to these maps, but that they must come to our office for such examination. By this means the maps aid in solving individual problems without opening the way to destructive criticism.

Aerial maps have cost Erie County about $100 a square mile, not including the mosaic. The limit of the return on this investment is determined only by the activities of the locality mapped and the people using it.

*By George C. Diehl, county engineer of Erie County, New York, in "Highway Magazine."

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Western Office: Monadnock Block, Chicago
A. PRESCOTT FOLWELL, Editor
W. A. HARDENBERGH, Associate Editor

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Satisfactoriness of Water

Fifty years ago cities in the Mississippi basin—and others—served to their citizens untreated river water which contained unbelievable quantities of mud and pathogenic bacteria. Consumers began to complain less and less mildly, and the practice became general of settling out the mud and incidentally a large percentage of the bacteria. Boards of health got busy and filtration plants removed most of the remaining bacteria. The water then was called "pure" by the water works officials but engineers preferred the word "safe." Then the remaining bacteria except a small fraction of a percent were destroyed by chlorine. All this effected an immense improvement and health statistics show how justified is the designation "safe."

But other ideas have been developing meanwhile. Water is put to other uses than drinking. A few million bacteria more or less do not interfere with the use of water for boilers or for washing, but hardness does. Iron stains clothes and wash bowls. So consumers demand the removal of hardness and iron, and they are being satisfied in a number of cities which is yearly increasing.

"Safe" does not adequately describe water which is free not only of bacteria but also of sediment, color, iron, sulphur and hardness, and the word "satisfactory" is suggested as applying to water which satisfies all consumers. This, of course, is not offered as a technical term but as a convenient one for popular use. For what satisfies one community will not satisfy another, and neither will be satisfied ten years from now with what meets all their wishes today. Dissatisfaction is the basis of progress.

For the present, satisfactoriness demands practical freedom from iron, sulphur and harness; methods of securing such freedom with certainty and at comparatively low cost have been developed; and where these matters are present in objectionable quantities, water works officials should remove them—if the consumers are willing to pay the necessary increase in rates. Water so treated is a manufactured article and the price must cover the cost of manufacture. Furniture can not be sold as cheap per pound as cord wood, and no reasonable consumer would expect to receive water from which objectionable matters have been removed by use of expensive apparatus and labor as cheap as that which flows into the mains direct from impounding reservoirs without treatment.

Instructing Operators of Water and Sewage Plants

That skillful operation of water purification and sewage treatment plants is as necessary to good results as are wise designing and careful construction has been stated frequently; and yet the statement is equally common that some of the former class of plants and many of the latter are woefully mismanaged through neglect, carelessness or ignorance.

State health boards are generally entrusted with supervision of the designing of such plants, but in most states either neither they nor any other state agencies are given any power to secure proper operation of them, or given such power, no funds are provided for exercising it by means of frequent inspection.

As a substitute for the exercise of such power, or supplementing it where it has been conferred, a number of state health boards have inaugurated the practice of holding annual "schools," "conferences" or

"courses" for the instruction of the operators of such plants and interchange of knowledge and experiences. These should be, and we believe are, of great benefit not only in imparting information concerning the operation of plants but also in giving the operators an ambition to make use of this information in order to become more expert and increase the efficiency of their plants. It is to be hoped that before long operators in all states will have such opportunities offered them by either the state health boards or engineering departments of colleges.

Among the latest of the states to offer such opportunities is Maryland, where the service took the form, last April, of a conference sponsored by the State Department of Health. A number of excellent papers, giving suggestions for plant operation, were read and discussed. We expect to publish abstracts of several of these in Public Works, believing that many of the suggestions made may be of help to readers of this journal.

Indianapolis Water Company Rate Case

Last November the United States Supreme Court handed down a decision relative to the valuation of water works plants for rate making purposes which is considered the most important decision in these matters that has been rendered in many years. This was a decision, on appeal from the U. S. District Court, in a suit brought by the Indianapolis Water Company against the Public Service Commission of Indiana for an injunction against the enforcement of certain rates prescribed by the Commission.

The salient features of the decision were presented in a paper before the Indiana Section of the American Water Works Association by Jos. J. Daniels, attorney at law of Indianapolis. Those especially interested should read the paper in the May *Journal* of that association. The briefest possible summary of the main points of the decision are given below.

Present value. Original cost is a fair measure of present value only if there has been no substantial change in the level of wages and prices since the plant was originally constructed. Otherwise original cost has no pertinency as evidence and would be rejected as irrelevent.

Cost of reproduction new at present prices, less depreciation, is a measure of present value in the absence of proof of facts requiring some departure therefrom. Such facts are those adduced with reference to the probable level of prices and wages during a reasonable period in the immediate future. "In every confiscation case, the future as well as the present must be regarded" says the opinion.

Reasonable rate of return. This can not fairly be based on rates plus brokerage at which the bonds were floated, but must also take into account the higher rate required by those who invest their money in stocks. The court did not fix this rate or the combined rate on the entire amount required to finance the utility, but did say that a reasonable rate of return was "not less than 7 percent."

The utility is entitled to allowance for working capital, and for water rights on proof of their existance.

Going value. "That there is an element of value in an assembled and established plant doing business and earning money, over one not thus advanced, is self-evident. This element of value is a property right and should be considered in determining the value of the property, upon which the owner has a right to make a fair return." In the case of the Indianapolis Water Co. the court held that "10 percent of the value of the physical elements would be low."

Depreciation. "Straight line" calculation of depreciation based on the present age and an assumed life of each element of the physical property, is admissible only when no direct evidence is obtainable as to its present condition and probable future usefulness. In the Indianapolis case two engineers had inspected the property and one based a calculation of depreciation on a consideration of the probable future life of the property as indicated by the conditions found, the other on the amount that would be required to restore the property to its condition when first installed. The court did not indicate its preference between these.

Paving Specifications for 1927

The state highway departments were asked last March (as one item of our annual questionnaire) to inform us what changes, if any, they were making in their specifications for 1927 work, as to either design or location, to meet increased traffic and loading on paved highways.

Only eight mentioned any changes. Twenty-two stated that no changes were being made; and the others, by leaving the question unanswered, probably implied that there were no changes to report. The changes reported were in most cases minor or the carrying out of policies previously formed.

For example, Ohio is widening pavements, reducing curvature, widening curves and thickening the edges of pavements. Oregon is gradually raising its standards of construction. South Carolina is relocating most of the roads that are being improved.

Vermont and West Virginia are using heavier concrete; the latter increasing base thickness from 6 inches to 8 and 9; and changing concrete pavement sections from 7-inch center and 6-inch edges to uniform 7 inches.

Tennessee is constructing shoulders on the main roads wide enough to park on. Pennsylvania is studying ultimate right-of-way widths of all state highways and filing plans establishing ultimate highway widths, not exceeding 120 feet, on locations which are satisfactory for the future.

Pennsylvania also reports that "Its pavement design is based upon an analysis of stresses induced by the maximum legal wheel load imposed at the critical position, with due allowance for subgrade variations and the impact loads."

Iowa's standard cross-sections are for 18 feet width of pavement with 2-inch crown, and 5-foot shoulders sloping 5 inches toward the pavement in fill and 2½ inches in cut; the concrete being 7 inches thick in the middle 10 feet, increased to 10 inches at the edges. At center joints, tongue

and groove construction is obtained by parting strips of 18 gauge steel held in place by steel pins 15 inches long, the strips being kept ½ inch below the pavement surface. These joints are provided with 5-foot dowels on 4-foot centers. Transverse joints are provided with 2-foot dowels on 2-foot centers, set 18 inches in the rear section and 6 inches in the forward section, with expansion tubes at expansion joints. Four longitudinal reinforcing bars of ⅝ inch steel are provided, one 9 inches from each edge and each side of the center joint and 2½ inches below the surface; with 2-foot lap at each splice.

Details of Pavement Design

Radius of curb returns. Pavement crown. Height of curb. Battered curbs. Safety zones. Traffic lanes. Center gutter streets. Sidewalk obstructions.

At the request of Miller McClintock, director of traffic survey of the Chicago Association of Commerce, the Western Society of Engineers some months ago appointed a committee to prepare suggestions concerning details of pavement design, especially those having a direct bearing on the capacity of the street for traffic. The committee consisted of L. S. Trainor, district engineer Portland Cement Association; A. J. Schafmayer, division engineer, Board of Local Improvements of Chicago; F. J. P. Seuel, engineer of street department, Commonwealth Edison Co.; and J. M. Mercer, acting as secretary.

This committee considered the subject under the following heads:

1. Minimum radius of curb return for different widths of streets.
2. Maximum crown of pavements.
3. Protecting sewer openings, drains, etc.
4. Maximum limits for height of curb.
5. Principles governing the construction of safety zones for street car loading.
6. Practice for safety islands on boulevards.
7. Proper width of traffic lanes.
8. Practice for marking traffic lanes in streets.
9. Markings for safety loading zones.
10. Concave or center gutter type of pavement.
11. Practice regarding sidewalk obstructions such as news stands, trash boxes, trolley poles, fire plugs, etc.
12. Practice regarding gutter openings for sidewalk crossings.
13. Use of battered curbs.

On these points the committee reported as follows:

1—*Radius of Curb Returns.*—The traffic density and character of traffic are not considered to be as direct a factor influencing the length of radius of the curb return as they are of the width of roadways and of street widths. Hence, in this case the main determining factors are the roadway width and the width of the sidewalk or of the sidewalk and planting space combined.

The need for more roadway space has led to the reduction of sidewalk space to the minimum and the same demand has led to the reduction of sidewalk facilities at intersections by increasing the radius of the curb corner. Practically all students of present traffic needs agree that all space possible should be allotted to the roadway traffic at street intersections. The ruling factor then becomes the space required for pedestrian traffic at intersections. A fair standard appears to be that the sidewalk space of the intersection measured at any angle should be at least equal to the width of the sidewalk. This condition would be met exactly by making the radius of the curb corner equal to the width of the walk. Since such a rule would result in a confusing variety of radius length, an effort has been made to establish a standard somewhat approximating these widths.

The following table shows the widths of roadway and sidewalks (including parkway) for various widths of streets:

66-ft. Street		80-ft. Street		100-ft. Street	
Rdy.	Side. walk	Rdy.	Side- walk	Rdy.	Side- walk
30	18	38	21	50	25
38	14	40	20	60	20
40	13	50	15	70	15
48	9	56	12	74	13

Since it is not at all uncommon for streets of various widths to intersect, various combinations can occur. In attempting to meet these various widths, a standard radius of 15 ft. has been adopted in Chicago for normal conditions.

One of the principal factors to be considered in connection with the establishment of standards for radii of curb returns, is the turning axis of motor cars in use today. We are advised that the minimum turning radius of stock cars is about 19 ft. and the majority of the stock cars in use in America today have a turning radius of approximately 25 ft. There can be no question but that the desirable radius for curb returns in one which will permit the car in the lane adjacent to the curb (which is the proper position for the car which is about to make a right-hand turn) to remain in the lane immediately adjacent to the curb until it is in the lane adjacent to the curb of the connecting roadway. The desirable radius of curb returns, therefore, can be set at 25 ft. and from the viewpoint of the user of the roadway, this is a standard which should be adhered to wherever the physical conditions so permit.

2—*Maximum Crown of Pavements*—Most authorities agree that if drainage were not necessary the ideal pavement section from a traffic standpoint would be a level surface. Since drainage is necessary, it must be considered. The former crown formulas such as Warren's, Rosewater's, etc., and the earlier ones which gave rather high crowns are being discarded for empirical figures and flatter crowns. The reason for this is that with the more true surfaces now common on the modern pavement, the former steep crowns are not necessary to insure lateral

drainage. There are certain factors, however, that tend to prevent crowns on pavements in a city like Chicago from being reduced to the degree that has been reached by some highway engineering organizations. One of these factors is the flat topography of Chicago. Another is the accumulation of snow, slush and ice in winter.

This topographical condition has resulted in the practice of securing longitudinal drainage by varying the depth of the gutters below the top of curb from the summits to the inlets. This results in a longitudinal undulation which is modified by varying the crown. When so modified the longitudinal undulation is not perceptible to any one driving within reasonable speed limits. The minimum crown, used at summits, varies from 3-4 per cent to 1 per cent of the roadway width in feet. The maximum crown, used at inlets, is approximately 2 per cent of the roadway width in feet.

The winter conditions with snow and slush require a slightly steeper transverse slope, to keep the surface reasonably well drained, than is necessary in warm climates. For such conditions where systematic snow removal is not in effect, the above mentioned minimum slope is inadequate, but it gives a measure of drainage and in such cases a standard adopted must necessarily be somewhat of a compromise between conflicting demands. On the other hand, the above maximum crown is not ideal from the standpoint of avoiding skidding when wet or slippery. However, the fact that the surface of the pavement follows a curved arc instead of intersecting planes results in the two central quarters which carry the faster traffic having a much flatter crown than the two outer quarters which carry the slow traffic and parked vehicles.

3—*Protecting Sewer Openings, Drains, Etc.*—There seems to be little that can be established as general practice in this regard, but there are certain factors which seem to require emphasis. Inasmuch as it is necessary to depress the cover or grating over a catch basin inlet in order to permit the ready flow of water from the pavement, special precaution should be taken to insure construction sufficiently strong to prevent any further depression due to the impact of heavy vehicles passing over the inlet. Sewer openings should be of ample capacity to carry away ordinary accumulation of trash and permit the speedy removal of water and slush.

4—*Height of Curb.*—The minimum height of the curb at intermediate summits between intersections should be 2 in. Less than this fails to give a clear line to the edge of the pavement and fails to retain the slush and water likely to be present at times.

The maximum height at inlets depends upon the distance between basins or inlets, the slope of the street and the height of the curb at the summit. An ideal maximum is 7 in. but details of design and consideration of economy in sewer appurtenances frequently indicate a curb height of 8 or 9 in. which should be permitted in particular cases.

The minimum height of curbs may be zero at crosswalks and in such cases the movement of pedestrian traffic is facilitated. However, it may be objected that a careless driver may drive upon the walks. This is true but a reckless driver is as likely to drive over a 7-in. curb as a zero curb. The maximum height at cross walks should never exceed 7 in.

5—*Safety Zones for Street Car Loading.*—Indiscriminate use of safety zones for street car loading should be avoided, but where it is found that the amount of traffic warrants the use of a safety zone, the elevated type is preferred. Safety zones are now being constructed in Chicago of concrete elevated 5 in. above the pavement and having the ends sloped. This type of safety zone has many advantages but wherever one is installed a mushroom light should be placed at least at its head to provide sufficient warning at night. Mushroom lights should be installed at each end of the safety zones which are not elevated and it may be desirable in congested sections to provide warning signs on removable standards. The elevated safety zone permanently settles the question of marking and provides easier entrance to street cars. There are now 140 safety zones in Chicago, most of which are of temporary type; that is, restrictions are removed at periods of light traffic. This is regarded as a temporary expedient and is under police regulation. The permanent elevated safety zone is thought to be more satisfactory. The greatest need for safety zones arises at the time of maximum passenger movement which coincides with the time of maximum vehicular movement but during times of light traffic, which invariably moves rapidly, there is continued need for safety zones. Removal of safety zone signs at such times is dangerous because of the false sense of security on the part of waiting passengers who think they are protected because they are standing on a portion of the pavement which is designated by paint as a safety zone.

6—*Safety Islands on Boulevards.*—Safety islands at important intersections on boulevards are recommended and should be elevated and lighted. These zones should be as narrow as feasible so as not to reduce appreciably the traffic capacity of the boulevard.

7—*Width of Traffic Lane.*—An extended examination of the literature published on this subject discloses practically nothing on the width of traffic lanes for city streets. There seems to be an almost universal agreement on a width of 10 ft. for traffic lanes on country highways. It is thought that this should also be adopted for boulevards and streets devoted to fast-moving traffic. On heavy-traffic streets, it is thought that this could be reduced to 9 ft. for the reason that such traffic moves slowly. Further reduction is not thought advisable because of the presence of wide motor trucks and busses. Nine feet seems to be generally regarded as sufficient for parallel parking.

8—*Marking Traffic Lanes in Streets.*—In general it seems impracticable to mark more

than the center line of streets. It might be desirable to mark additional lines at such places as winding drives through parks and on boulevards, but in general the track over such streets seems to take care of itself quite satisfactorily.

9—*Marking for Safety Loading Zones.*—This is covered under section 5.

10—*Concave or Center Gutter Streets.*—Concave street pavement has been constructed in the new market district between Morgan St. and Racine Ave. Several other streets are now under contract to be improved with this type of pavement.

The pavements in the Market district have given satisfactory service so far. This district, however, has a very specialized type of traffic. Numerous arguments have been made for and against this pavement section. It appears quite certain that a saving in sewer costs can be effected and a saving in filling; but if cutting is required the latter item will be increased.

From the standpoint of expediting traffic and ease and safety, this type of street has yet to demonstrate its desirability.

11—*Sidewalk Obstructions.*—Certain sidewalk obstructions may be removed while others are more or less stationary. Trolley poles and fire plugs are located according to more or less inflexible conditions. Trash boxes should never be permitted to be located near the corner. Mail boxes would be just as satisfactory if they were installed on the building fronts as soon as the people became accustomed to looking for them there. News stands are the worst offenders. They invariably seek the corners. They should not be permitted within 25 ft. of an intersection and should be located, preferably, in the middle of the block. City ordinances permit such stands to sell newspapers only. Practically all are violating this ordinance. The size of the news stand should be limited to that which is sufficient for the display of newspapers only.

12—*Gutter Openings for Sidewalk Crossings*—The practice of building an extension of the sidewalks into the street and providing an under passage for the gutter at the curb line, has been discontinued in Chicago but many old streets with such cross walks exist. This has the effect of making travel in the outside of the street almost impossible.

13—*Battered Curbs.*—Battered curbs have been used on many pavements and have certain advantages. Two of the principal advantages claimed for such curbs are: (1) The ease of turning an automobile out, even when parked tight up against the curb, and (2) There is not the tendency for wheels to rub against this curb, thus saving damage to sides of tires and rims and also to the curb itself.

On pavements where the topography lends itself to a curb design of uniform height this type of curb offers little difficulty. But with varying curb heights it presents several difficulties. If a uniform rate of batter is maintained and the line of connection with the gutter is held straight, the upper roadway face will meander in and out at the summits and inlets respectively. If the upper face is held to a true line, the lower edge meanders giving at some places a wider roadway and at others a narrower width. All these cause difficulties in setting concrete forms. If both top and bottom are held to a straight line and the rate of batter is varied a warped surface results with added difficulty in setting forms. In addition to these items, the appearance of poor alignment and the added opportunity its variableness would offer the many lawyers, who levy tribute on Chicago's improvements, to make still more vicious attacks are further reasons against its adoption in Chicago.

It is understood that the city of Chicago has abandoned the combined curb and gutter due to many failures of the gutter section. It proposes to use a straight curb 9 in. wide by 20 in. deep which will be installed after the pavement is built. The gutter will be built integral with the pavement and the curb will have a vertical face.

Improvement In 1926 California Pavements*

Increase in surface smoothness in both portland cement and asphalt concrete most important accomplishment. Laboratory methods and field comparisons.

A general increase in surface smoothness was the most important improvement accomplishment during 1926 in the construction of California state highway pavements. This is the report of the Construction Department following a careful review of all projects placed under contract during the past season. Improvement is shown in both asphalt concrete and cement concrete pavements, which means not only improved riding qualities but less traffic impact and longer lived state highways.

Advantage has been taken during the year of every opportunity to improve construction practices and to better results by revisions of the specifications. Constructive criticism has been encouraged; and much credit is due the engineers in the field for suggestions and ideas that have contributed materially to the results of the year's work.

The following review of 1926 California state highway paving projects will be of interest to engineers:

CONSTRUCTION METHODS

Portland Cement Concrete. Finishing of cement concrete pavements has been standardized by the adoption of the pliable wooden longitudinal float. This float, which replaces the push float, canvas belt, and rubber hose for final finishing, was introduced in California by construction engineer C. S. Pope, and was developed largely by resident engineer W. D. Eaton, of Division VII.

During the 1926 construction season, longitudinal

*Reported by Earl Withycombe, Assistant Engineer, Construction Department, in "California Highways," March, 1927.

joints have been built on almost perfect alignment and free from subsequent spalling by the development of what is known as the weakened plane type. This joint was introduced on state work by division engineer S. V. Cortelyou of Los Angeles and was perfected by resident engineer Eaton. It is made by driving a groove two inches in depth in the surface of fresh concrete on the center line of the pavement. Finishing is done with a hand tool that acts as a combined double edger and groover. This groover is handled in somewhat the same manner as the walking edger, a tool used adjacent to the side forms.

On second-story work this method of making the longitudinal joint has the added advantage of not leaving any unnecessary material in the slab. In the thickened center type of the pavement, to reduce the area of unbroken concrete, a wooden strip ½ inch by 4 inches is fixed in a vertical position on the subgrade directly under the line of the proposed groove. The groove is poured with asphalt to form a traffic guide line before the pavement is opened to traffic. Expansion joint intervals have been reduced to 50 feet, and, in special cases, to 25 feet, without sacrificing any of the normal riding qualities of the pavement. This has been accomplished by the use of a prepared joint material, held in position during the placing of the concrete by means of steel plates cut to cross section in one continuous piece and suspended from the side forms. The joint material is slightly submerged to permit unbroken, continuous finishing. Desired alignment is secured immediately following the removal of the steel plates by truing up the joints to a chalk line.

To control the unsightly cracking which sometimes results from contraction, intermediate weakened plane transverse joints are now being placed between the regular expansion joints. Such weakened joints are made by driving an oiled steel plate, two inches in depth, to slightly below the surface of the freshly placed concrete. Finishing is carried on over the joint and edging is performed after the concrete has sufficiently set. Generally the plates may be removed after four hours. The opening is always filled with asphalt before the project is opened to traffic.

All regular expansion joints are now being doweled to prevent subsequent settlement at the ends of slabs.

No change was made during the year in the method of reinforcing second-story pavement of 20-foot width. Such slabs still carry bar or mesh reinforcement over the edges of the old pavement in the outer four and a half feet. On new work it has been the practice to reinforce the entire slab in areas where subgrade conditions are questionable.

A marked improvement has been made in the method of placing reinforcing steel by the use of a new device designed and patented by resident engineer Eaton. This device suspends rather than supports the steel to insure its proper place in the slab. After the concrete has been placed the supporting device is removed, leaving no unnecessary material in the pavement.

Concrete for California pavements is now being designed in the field to conform to the requirements of the particular materials available for use on the basis of the maximum density methods perfected by construction engineer Pope and materials and research engineer C. L. McKesson. All mixtures are similar in that the ratio of cement to volume of concrete in place is constant.

No wide departures have been made with respect to equipment, except that on one project two mixers were operated opposite each other on the shoulders to pour a 20-foot slab. On pavement widening, where a centrally mixed concrete can be used to advantage, a new type of plant with a pug mill mixer has been perfected. From the result of tests made on this plant the usual mixing time of 60 seconds has been reduced to 45, with indications that the time may be reduced still further due to the rapidity of pug mill mixing.

The policy of the department is to allow the contractor or equipment manufacturer to operate any mixer in a manner other than that called for by the specifications, provided the strength of the resulting concrete, as determined by compression tests, is equal to that produced with the equipment operating in the manner specified.

Asphaltic Concrete. Increase in smoothness of asphaltic pavements was accomplished solely by constant vigilance on the part of the field forces, as no changes in methods of finishing such pavements were made during the year. (A mechanical method of finishing similar to that in use on portland cement concrete has been experimented with recently on other public work in California, and, although it is not, as yet, a complete success, the results indicate future possibilities.)

Results of experimental work in 1925 with mixtures containing a high percentage of limestone dust filler are encouraging. These studies were continued during the past season on four projects of considerable length in widely separated sections of the state. On these jobs pavements were placed with an increase of 50 to 75 per cent of filler over the normal amount required in the standard California mix for asphalt concrete.

The former practice of sealing the surface of asphaltic pavements with a coat of hot asphalt covered with hot stone chips has been discontinued, due to the slipperiness in wet weather of the resulting surface. Many pavements have been laid successfully simply by rolling hot stone chips into the freshly compacted open top surface.

During the past season another type of nonskid surface, giving much promise of permanent success, was laid on a number of projects. Hot stone chips, previously coated in the pug mill mixer with from 1½ to 2 per cent asphalt were applied to the surface and rolled in immediately after initial compression. Because of the dryness of the mixture now in use, it appears unlikely that this type of finish will be driven into the surface for some time. The nonskid qualities of this type of asphalt pavement finish, at the present time, are, apparently, superior to those of any other type. The department is indebted to Construction Engineer Pope for the introduction of this idea in California and to Resident Engineer H. B. La Forge for the field adaptation.

No radical changes have been made in equipment in use on asphaltic concrete construction. Minor improvements have been made on mixing plants, the

most notable of which is a lime dust proportioning device perfected by the Cornwall Construction Company of Santa Barbara. At this plant, lime dust is proportioned by weight on the ground level and conveyed to a storage hopper alongside the aggregate box from which it is shot into the center of the mixer along with other aggregates. This gives a maximum of efficiency with a minimum of labor. Asphalt plants, manufactured in California, have been perfected to produce 400 tons of mix per day with but one operator necessary on the platform.

Experiments during the season with the mixing time of asphaltic concrete in pug mill mixers led to a reduction in duration of mixing from 60 seconds per batch to 45 seconds. This has materially increased the average daily production which is being reflected in decreased bid prices.

RESULTS OF LABORATORY METHODS

Portland Cement Concrete. The average compressive strength of all Portland cement pavement and shoulder concrete for the 1926 season was 4,145 pounds per square inch at 28 days. The mix was the California Highway Commission standard class "A," or six sacks of cement per cubic yard of concrete. Individual full width pavement strengths varied from 3,144 pounds to 5,304 pounds per square inch, while shoulder concrete ranged from 2,110 pounds to 4,099 pounds per square inch.

Wide range in compressive strengths is due somewhat to differences in structural strengths of aggregates from various sources and to a slight variation in strength of cement.

Asphalt Concrete. A change has been made in the laboratory method of determining specific gravity of compressed asphaltic pavements. Determination is made of the sample as received; it is broken down and the specific gravity is expressed as a percentage of the composite specific gravity of the aggregates. By this method the voidage in the pavement sample is made apparent at a glance.

Voids in surface mixtures laid during 1926 ranged from 4.2 per cent to 0.6 of one per cent, indicating that a remarkably dense and impervious pavement has been secured. Voidage in these mixtures is but one-third of that in present Portland cement concrete.

FIELD COMPARISON

Portland Cement Concrete. Surface roughness on cement concrete pavements, as determined by the vialog, decreased during the year from an average of 14.3 inches per mile in 1925 to 7.1 inches per mile in 1926, or 50 per cent. Credit for this result is due to careful field inspection and control and to the improved methods worked out for making the final finish.

A new type of surface finish also has been adopted on concrete shoulder construction with an exceptional increase in surface smoothness. The 1925 average of 26.7 inches of roughness per mile for shoulders was reduced in 1926, to 4.7 inches per mile, a decrease of 82 per cent.

Early comparisons of crack intervals on newly constructed pavements has not been accepted as a correct indicative of the relative merits of the projects, with respect to resistance to cracking from temperature changes. A progressive study of the yearly condition is now believed to be the best index of this quality.

Cement control on 1926 projects ranged from 2.64 per cent to nine-tenths of 1 per cent and averaged 1.49 per cent for all jobs; the general average for 1925 was 1.73 per cent. This indicates that, during 1926, the field men made good progress in maintaining the proper cement yield.

Concrete pavement yardage increased in daily average production from 179 cubic yards in 1925 to 186 cubic yards in 1926.

Asphalt Concrete. Surface roughness on asphaltic concrete pavements for 1926 averaged 24.1 inches per mile as compared with 33.2 inches in 1925, or a decrease of 27 per cent.

Daily tonnages produced in 1926 varied from 69 tons to 388 tons and averaged 270 tons for all jobs. As the average for 1925 was but 214.4 tons, there was an increase in production during 1926 of 26 per cent.

Surface Roughness, All Types. Since the vialog was first brought into use for comparison of surface roughness, the yearly averages denote a steady improvement in the riding qualities of all types of completed pavements. The average for 1924 was 22.2 inches of roughness per mile; for 1925, 18.8 inches; and for 1926, 15.0 inches, a decrease of 20 per cent over the 1925 record.

California state highway pavements are becoming constantly smoother and therefore better. Elimination of the impact which results from vehicles passing over unnecessary roughness in the pavement surface means greater wearing qualities and a longer life for the highway surface. Much of the benefit which comes from added initial strength of pavements is lost without smoothness of surface.

New Jersey Limits Life of Bonds

A recent New Jersey law limits the life of bonds to be issued for various public improvements and declares that the period of usefulness of these improvements shall be deemed to be as follows: Sewer systems, including treatment plants, 40 years; water supply projects, 40 years; garbage collection and disposal, including incinerators, 10 years; bridges of steel, iron, or concrete, 30 years; sand and gravel roads, 5 years; water bound and bituminous macadam roads, 10 years; bituminous concrete roads, 15 years; bituminous concrete on concrete base, and cement concrete roads not less than 6 inches thick, 20 years; land for roads, 30 years; curbs, walks and gutters, 10 years, fire engines and apparatus, 10 years; and grade crossing elimination, 50 years.

"Alabama Highways"

The latest addition to the list of state highway department publications is *Alabama Highways,* published by the Alabama State Highway Department, Montgomery, of which Col. Woolsey Finnell is director, and Henry J. Law and John S. Turner associates. The April issue, which is Vol. 1, No. 1, contains 24 pages, with illustrations showing road and bridge work in Alabama.

Information Concerning Water Works

More than seven hundred water works officials report the amounts of pipe laid last year, the total lengths in service and the numbers of appurtenances set. Also equipment used for trenching and backfilling and other labor-saving appliances. More than eighty percent of the plants municipal.

In this issue PUBLIC WORKS presents the results of its annual survey of the water works field. Through the cooperation of more than seven hundred men representing that number of cities, which cooperation is hereby gratefully acknowledged, an unusually broad and comprehensive survey has been possible. Data were furnished regarding street mains and appurtenances placed in 1926, and the total in use, equipment and machinery used in water works operation, and methods of, and appliances used for, trenching, backfilling, tamping, pipe cutting and calking, and locating pipes and leaks. In the tables following are given the data concerning cast iron, steel and other mains laid in 1926 and the total in use, and the number of hydrants and gate valves placed in 1926, and the total number now in service. The methods and machinery employed in the various cities for trenching, backfilling, tamping, cutting and calking pipe, and locating pipe and leaks will be described in the July issue.

As in the past, no attempt has been made to list all sizes of the pipe in service, but cast iron mains have been grouped into three classes, under 6-inch, 6-to-12-inch, and over 12-inch. Steel mains have been classed as under 12-inch and over 12-inch.

The forecast for the coming year seems to indicate that water works construction during the next twelve months will exceed considerably that during the year just past. More mains are projected; more meters and other appurtenances are expected, and more cities seem to be planning treatment plants or additions to existing water works structures.

Cast Iron Pipe Laid in 1926

State and City	Municipal or Private	Under 6-inch	6", 8", 10" and 12"	Over 12"
Alabama:				
Gadsden	M	650	6,400	.....
Arkansas:				
Rogers	P	300	.....	.....
Arizona:				
Glendale	M	1,800	16,000	.....
Tucson	M	492	12,182	.....
California:				
Bakersfield	P	17,500	6,780	.....
Modesto	M	2,092	4,300	.....
Monterey Park	M	2,000	.....	.....
National City	P	21,100	6,750	.....
Salinas	P	3,508	2,295	.....
San Buena Ventura	M	32,845	15,150	.....
Sacramento	M	3,263	30,045	.....
San Jose	P	48,668	31,723	.....
Santa Barbara	M	6,581	44,683	480
Colorado:				
Colorado Springs	M	2,173	5,639	.....
Greeley	M	1,285	5,143	.....
Pueblo	M	3,000	.....	.....
Connecticut:				
Ansonia	P	180	3,355	.....
Bristol	M	3,896	10,724	.....
Bridgeport	P	1,110	59,482	1,800
Darien	P	582	6,802	.....
Farmington	P	.....	8,000	.....
Hartford	M	16	46,106	4,452
Rockville	P	.....	300	.....
Shelton	P	109	1,414	25,287
Southington	M	.....	9,076	.....
South Manchester	P	5,791	5,291	.....
Stonington	P	.....	640	.....
Wallingford	M	.....	5,280	.....
Westport	P	872	14,935	.....
Willimantic	M	.....	3,126	.....
District of Columbia:				
Washington	M	2,727	95,392	25,371
Florida:				
Lakeland	M	4,000	15,000	.....
Georgia:				
Bainbridge	M	900	6,600	.....
Cedartown	M	4,000	5,500	.....
Cartersville	..	8,600	2,060	.....
Newnan	M	.....	4,500	.....
Sandersville	M	.....	1,800	.....
Thomasville	M	.....	11,450	.....
Illinois:				
Bloomington	M	.....	4,500	.....
Freeport	P	353	3,658	.....
Geneva	M	12,800	9,200	.....
Harvey	M	.....	131,546	12,498
Lake Forest	M	3,000	.....	.....
Mattoon	M	.....	5,000	.....
Morrison	M	1,500	.....	.....
Oak Park	M	465	16,279	.....
Quincy	M	261	16,451	.....
Rock Island	M	.....	8,000	.....
Springfield	M	8	17,042	360
Watseka	M	1,000	.....	.....
West Chicago	...	.....	600	.....
Indiana:				
Auburn	M	976	.....	.....
Attica	M	900	.....	.....
Connersville	M	1,336	13,488	.....
Decatur	M	3,085	.....	.....
Elkhart	M	.....	17,584	846
Fort Wayne	M	.....	7¾ mi.	1¼ mi.
Goshen	M	.....	4,380	.....
Jasper	M	400	.....	.....
Kendallville	M	3,550	1,075	.....
La Fayette	M	1,806	1,356	.....
Lebanon	..	.....	3,000	.....
Marion	M	.....	11,960	.....
Martinsville	M	338	.....	.....
Muncie	P	.....	6,014	.....
Michigan City	M	680	11,206	.....
Mishawaka	M	140	22,547	3,407
New Albany	P	3,337	2,950	.....
Peru	M	.....	.....	2,700
Princeton	P	3,126	1,200	.....
Shelbyville	P	.....	1,500	.....
South Bend	M	408	111,721	2,868
Iowa:				
Boone	M	6,454	463	.....
Burlington	P	59	7,633	59
Cedar Rapids	M	686	11,458	.....
Charles City	M	7,289	.....	.....
Cresco	M	1,600	1,206	.....
Dubuque	M	200	4,800	.....
Fort Dodge	..	4,582	8,124	1,072
Marshalltown	M	3,395	.....	.....
Mason City	M	5,000	.....	.....
Muscatine	M	1,000	1,500	.....
Perry	M	6,000	.....	.....
Sioux City	M	.....	331,800	17,000
Storm Lake	..	3,000	.....	.....
Washington	M	600	.....	.....
Kansas:				
Augusta	..	3,800	.....	.....
Cherryvale	M	1,250	.....	.....
Coffeyville	M	5,000	1,000	.....
Herington	M	400	.....	.....
Hutchinson	P	.....	4,752	.....
Junction City	M	1,200	.....	.....
Kansas City	M	85	17,077	5,206
Leavenworth	M	1,500	2,000	.....
Lawrence	M	1,000	.....	.....
Kentucky:				
Ashland	M	3,176	27,416	.....
Covington	M	2,000	1,500	.....
Glasgow	P	500	.....	.....
Henderson	M	.....	2,400	.....
Hopkinsville	P	243	1,936	.....
Louisville	M	1,818	187,854	18,440
Somerset	P	.....	1,200	.....
Louisiana:				
Jennings	M	300	2,700	.....
Ruston	M	1,200	4,600	.....

Cast Iron Pipe Laid in 1926

State and City	Municipal or Private	Under 6-inch	6", 8", 10" and 12"	Over 12"
Maine:				
Augusta	M	.....	8,223	1,074
Biddeford	P	20,000	8,030	.....
Calais	P	1,000	.....	.....
Norway	P	500	500	.....
Portland	M	32,950c	25,222	5,899
Showhegan	P	1,703	480	.....
Sanford	P	2,000	2,500	.....
Maryland:				
Baltimore	M	5,280	78.4 mi.	8.8 mi.
Hagerstown	M	.....	6,400	.....
Pocomoke City	M	2,000	.....	.....
Salisbury	M	1,200	36,200	2,400
Washington San. Dist.	M	10,090	163,042	22,675
Massachusetts:				
Andover	M	4,015	3,652	.....
Athol	M	.....	2,458	.....
Belmont	M	.....	15,778	.....
Brockton	M	.....	4,836	.....
Cherry Valley	M	.....	1,000	.....
Concord	M	.....	3,380	.....
Danvers	M	894	8,805	15,080
Dracut	M	.....	837	.....
Dudley	M	.....	1,356	.....
Everett	M	.....	4,930	.....
Falmouth	M	904	7.1 mi.	.....
Fitchburg	M	.....	2,747	2,217
Framingham	..	.....	21,307	.....
Greenfield	M	.....	5,308	.....
Haverhill	M	335	8,768	148
Leominster	M	240	1,338	.....
Lexington	M	1,000	14,949	.....
Lowell	M	.....	4,580	.....
Malden	M	65	7,301	.....
Medford	M	610	24,352	.....
Milford	P	.....	480	.....
Milton	M	.....	18,000	3,312
Millbury	P	.....	500	.....
New Bedford	M	.....	7,393	.....
Newburyport	M	.....	2,633	.....
North Adams	M	.....	7,023	.....
Northampton	M	.....	21,177	.....
Peabody	M	.....	2,000	.....
Rockford	M	.....	3,114	.....
Shrewsbury	M	363	3,268	.....
Somerville	M	386	7,443	4,861
South Hadley Falls	M	.....	350	.....
Spencer	M	.....	1,350	.....
Springfield	M	.....	32,415	3,630
Swampscott	M	4,790	.....	.....
Taunton	M	.....	11,182	.....
Uxbridge	..	.....	3,600	.....
Wareham	M	.....	900	.....
Wakefield	M	.....	2,199	.....
Waltham	M	141	13,433a	.....
Warren	M	.....	218	.....
Williamstown	P	500	4,500	.....
Winthrop	M	.....	4,550	.....
Michigan:				
Albion	M	400	2,000	.....
Ann Arbor	M	.....	11,144	.....
Bay City	M	3,600	8,250	.....
Benton Harbor	M	984	677	.....
Coldwater	M	.....	2,377	.....
Detroit	M	.....	825,661	89,107
Highland Park	M	.....	3,000	.....
Holland	M	.....	2,843	.....
Houghton	M	.....	.....	.....
Ironwood	M	500	150	.....
Jackson	M	.....	10,982	.....
Kalamazoo	M	1,000	15,000	684
Ludington	M	.....	4,000	.....
Mt. Clemens	M	821	5,438	.....
Niles	M	277	2,217	.....
Rochester	M	500	.....	.....
St. Clair	M	375	.....	.....
St. Louis	M	1,500	900	.....
South Haven	M	1,300	.....	.....
Sturgis	M	3,026	1,500	.....
Traverse City	M	.....	2,000	.....
Yale	M	2,000	.....	.....
Minnesota:				
Anoka	M	500	.....	.....
Bemidji	M	500	.....	.....
Cloquet	M	.....	100	.....
Duluth	M	.....	22,719	.....
Hibbing	M	.....	7,851	.....
Luverne	..	3,240	.....	.....
Melrose	M	1,300	.....	.....
Minneapolis	M	44,372	18,577	6,136
Red Wing	M	.....	3,180	.....
Rochester	M	1,668	5,528	.....
St. Peter	M	.....	1,900	.....
Stillwater	M	.....	6,008	.....
Willmar	M	3,390	.....	.....
Mississippi:				
Jackson	M	12,000	4,200	.....
Laurel	..	.....	4 mi.	.....
Vicksburg	M	.....	5,280	.....
Missouri:				
Chillicothe	M	.....	1,200	.....
Clinton	P	4,000	2,000	.....
Columbia	M	17,813a	.....	.....
Excelsior Springs	P	1,159	.....	.....
Fulton	M	.....	800	.....
Jefferson City	P	.....	2,000	.....
Liberty	M	1,000	.....	.....
Marshall	M	2,300	11,500	.....
West Plains	M	2,000	.....	.....
Montana:				
Billings	M	753	10,104	2,643
Great Falls	M	80	7,206	.....
Kalispell	M	500	14,250	.....
Nebraska:				
Columbus	M	.....	1,200	.....
Fremont	M	.....	2,500	.....
Grand Island	M	.....	5,000	.....
Hastings	M	4,850	.....	.....
Omaha	M	711	127,641	25,983
Superior	M	2,600	400	.....
New Hampshire:				
Claremont	M	.....	2,200	.....
Franklin	M	.....	2,369	.....
Keene	M	700	3,053	.....
Lebanon	M	700	1,500	.....
Manchester	M	157	11,768	6,256
Newport	M	100	.....	.....
New Jersey:				
Belleville	M	.....	15,298	.....
Dover	M	7,212	.....	.....
Hightstown	M	500	1,800	.....
Irvington	P	153	22,900	.....
Montclair	M	.....	14,190	.....
Nutley	M	.....	12,000	.....
Rahway	M	2,914	19,345	.....
Red Bank	..	7,000	500	.....
Rockaway	M	1,000	.....	.....
Verona	M	.....	7,920	.....
New Mexico:				
Deming	M	.....	7,000	.....
Tucumcari	M	600	.....	.....
New York:				
Albany	..	545	52,641	302
Auburn	M	.....	1,080	.....
Avon	M	1,000	13,000	.....
Beacon	M	860	2,100	.....
Binghamton	M	400	10,778	.....
Carthage	M	700	1,700	.....
Catskill	M	300	.....	.....
Cortland	M	200	3,000	.....
Dansville	M	.....	200	.....
Elmira	M	294	12,212	.....
Fort Plain	..	10,560	21,120	.....
Geneva	M	.....	302	.....
Glens Falls	M	1,367	.....	.....
Gloversville	M	.....	2,522	.....
Hoosick Falls	M	2,000	1,000	.....
Kingston	M	2,000	2,500	4 mi.a
Newburg	M	.....	3,140	.....
Olean	M	5,000	5,900	.....
Oneonta	M	.....	500	.....
Ossining	M	.....	1,200	.....
Oswego	M	.....	3,500	.....
Peekskill	M	.....	5,000	.....
Perry	M	200	3,500	.....
Penn Yan	M	.....	8,870	.....
Scarsdale	M	.....	39,082	.....
Saugerties	M	2,500	700	5 mi.
Utica	P	1,122	22,070	.....
Waterford	M	270	750	.....
North Carolina:				
Albemarle	M	.....	1,200	.....
Gastonia	M	.....	10,690	.....
Greensboro	M	.....	33,529	.....
Kinston	M	.....	1,000	.....
Raleigh	M	443	54,153	.....
Rocky Mount	M	.....	2,785	.....
Statesville	M	10,000	5,000	.....
Wilmington	M	.....	2,850	.....
North Dakota:				
Fargo	M	.....	18,077	9,249
Ohio:				
Akron	M	0.32mi.	16.45 mi.	0.66 mi.
Barberton	M	150	5,700	.....
Bedford	M	.....	10,568	.....
Bowling Green	P	34	2,582	.....
Cincinnati	M	3,804	104,926	37,289
Columbus	M	3,530	100,501	2,492
Defiance	M	1,600	72	.....
Dennison	P	2,994	656	.....
East Liverpool	M	600	1,000	.....
East Cleveland	..	.....	5,382	.....
Gallipolis	M	.....	1,000r	.....
Huron	M	4,092	4,201	.....
Kent	M	.....	450	.....
Lakewood	..	.....	4,600	.....
Lancaster	M	720	6,000	.....
Lima	M	848	2,400	.....
Lorain	M	700	1,000	.....
Martin's Ferry	M	.....	6,800	.....
Medina	M	400	.....	.....
Orrville	M	376	990	.....
Salem	M	5,280	5,000	.....
Struthers	P	.....	5,996	2,700
Tiffin	P	1,617	2,880	.....
Urbana	M	1,100	.....	.....
Warren	M	.....	10,422	1,998
Youngstown	M	563r	50,316	1,312

Cast Iron Pipe Laid in 1926

State and City	Municipal or Private	Under 6-inch	6", 8", 10" and 12"	Over 12"
Oklahoma:				
Blackwell	M	5,000	1,000	.....
Mangum	M	300	.....	.....
Newkirk	M	1,000	6 mi.	.....
Stillwater	..	3,600	.....	.....
Oregon:				
Eugene	M	8,000	6,600	.....
Pendleton	..	600	3,000	.....
The Dalles	M	.....	1,200	.....
Pennsylvania:				
Allentown	M	.....	14,700	.....
Ashland	M	2,000	6,000	.....
Bradford	M	3,800	.....	.....
Clearfield	P	627	430	.....
Corry	P	1,847	543	.....
Coatesville	M	900	700	.....
Connellsville	P	5,000	2,000	.....
Coplay—See Northampton				
Duquesne	M	400	200	.....
Frackville	P	1,000	500	.....
Huntingdon	M	1,000	.....	.....
Jersey Shore	P	1,450	925	.....
Kittaning	P	.....	300	.....
Lancaster	M	2,066	4,209	.....
Lehighton	P	1,936	1,188	.....
Mt. Carmel	P	.....	1,317	.....
Northampton	P	5,500	5,550	.....
North Catasauqua—See Northampton				
Phoenixville	M	150	5,000	.....
Reading	M	.....	14,158	.....
Reynoldsville	M	842	.....	.....
Sayre	P	500	1,000	.....
Schuylkill Haven	M	5,280	.....	.....
Shamokin	P	81	6,405	.....
Sharpsville	M	1,500	.....	.....
Summit Hill	P	.....	900	.....
Uniontown	P	.....	10,332	11,500
Whitehall—See Northampton				
Wilkinsburg	P	1,662	24,732	31,728
Woodlawn	P	702	4,259	.....
York	P	.....	10,447	.....
Rhode Island:				
Anthony—See Warwick				
Arctic—See Warwick				
Centerville—See Warwick				
Crompton—See Warwick				
East Providence	P	.....	9,421	.....
Harris—See Warwick				
Imdinck—See Warwick				
Narragansett—See So. Kingston				
Phoenix—See Warwick				
Riverpoint—See Warwick				
South Kingston	P	315	.....	.....
Warwick	P	.....	2,442	.....
Washington—See Warwick				
Westerly	M	249	2,229	.....
Woonsocket	M	.....	17,446	.....
South Carolina:				
Bennettsville	M	.....	3,600	.....
Columbia	M	290	13,515	364
Charleston	M	1,369	16,279	7,805
Easley	M	.....	5,000	.....
Gaffney	M	.....	6,000	.....
Rock Hill	M	2,000	.....	.....
South Dakota:				
Brookings	M	300	.....	.....
Mitchell	..	584	1,724	.....
Tennessee:				
Clarksville	M	.....	1,800	.....
Dyersburg	M	.....	3,000	.....
Erwin	P	.....	400	.....
Memphis	M	.....	132,255	.....
Milan	M	7,000	2,000	.....
Nashville	M	22,892	80,107	42,809
Shelbyville	P	8,000	3,500	.....
Texas:				
Big Spring	M	3,000	2,500	.....
Childress	M	.....	27,275	.....
Dallas	M	4,301	68,620	8,434
El Paso	M	1,500	19,100	.....
Texas (continued)				
Ennis	M	4,000	4,000	.....
Graham	M	1 mi.	.....	.....
Greenville	M	.....	4,000	.....
Mart	..	3,000	6.3 mi.	.....
Mexia	..	.....	5,680	.....
San Antonio	..	.....	26,400a	.....
Smithville	P	2,000	.....	.....
Tyler	M	4,033	9,522	.....
Weatherford	P	1,400	.....	.....
Waco	M	990	8,207	.....
Wichita Falls	M	3,488	16,844	488
Utah:				
Tooele	M	3,000	.....	.....
Vermont:				
Barton	M	1,200	.....	.....
Brattleboro	M	.....	650	.....
Newport	M	1,500	.....	.....
Rutland	M	.....	1,900	400
Virginia:				
Charlottesville	M	4,500	9,841	.....
Danville	M	.....	4,877	.....
Martinsville	M	7,300	8,000	.....
Newport News	M	.....	21,218	.....
Washington:				
Aberdeen	M	8,000	8,500	2,700
Centralia	M	.....	.....	600
Dayton	M	.....	23,120b	.....
Pullman	M	600	1,200	.....
Spokane	M	30,672	.....	.....
Tacoma	M	870	39,900	.....
Winlock	P	100	.....	.....
Yakima	M	.....	5,720	.....
West Virginia:				
Beckley	P	.....	1,700	.....
Morgantown	P	3,872	923	.....
Wisconsin:				
Algoma	M	.....	3,000	.....
Appleton	M	594	13,003	.....
Ashland	P	411	.....	.....
Baraboo	M	.....	2,000	.....
Chippewa Falls	..	.....	900	.....
Cudahy	M	.....	1,760	.....
Fond du Lac	M	6,696	15,554	.....
Fort Atkinson	M	188	1,346	.....
Green Bay	M	355	8,189	.....
Janesville	M	.....	3,351	.....
Jefferson	..	2,306	2,651	.....
Kaukauna	M	.....	2,590	.....
La Crosse	M	.....	4,034	.....
Ladysmith	M	.....	675	.....
Lake Geneva	M	1,000	.....	.....
Madison	M	1,279	16,647	.....
Menasha	M	672	2,357	.....
Marinette	P	1,406	.....	.....
Milwaukee	M	.....	177,382	37,638
Neenah	..	.....	6,408	.....
Oconomowoc	M	1,132	80	.....
Port Washington	M	300	.....	.....
Reedsburg	M	1,953	.....	.....
Richland Center	M	330	.....	.....
Sturgeon Bay	M	.....	3,790	1,000
Shawano	M	900	3,500	.....
Watertown	M	1,606	3,478	.....
Wauwatosa	M	21,120	7,880	.....
Wisconsin Rapids	M	.....	1,780	.....
Canada:				
Charlottestown, P. E. I.	M	300	.....	.....
Guelph, Ont.	M	3,485	1,761	.....
Hamilton, Ont.	M	4,165	450	.....
Kitchener, Ont.	M	331	8,766	.....
Orillia, Ont.	M	200	.....	.....
St. Catherines, Ont.	M	4,000	.....	.....
St. Thomas, Ont.	M	.....	500	.....
Toronto, Ont.	M	.....	29,888	2,827
Winnipeg, Man.	M	.....	15,256	.....

a—All sizes; b—now being laid; c—coated; r—relaid.

Plants Private or Municipal

A number of cities, while reporting whether the plants are municipal or private, did not report any cast iron pipe, and therefore, are not included in the above table. In order to complete the list of municipal and private plants reporting, the names of such cities are given below, arranged by states. Also the total number is given, for each state, of all cities which reported under each head.

ALABAMA: Municipal, 3; private, 0.
Municipal: Talladega, Union Springs.

ARIZONA: Municipal, 2; private, 0.
Municipal: Bisbee.

ARKANSAS: Municipal, 2; private, 3.
Municipal: Harrison, Nashville. **Private:** Arkadelphia, West Haven.

CALIFORNIA: Municipal, 10; private, 4.
Municipal: Dinuba, Lodi, Madera, Redlands, Santa Maria.

COLORADO: Municipal, 4; private, 0.
Municipal: Alamosa.

CONNECTICUT: Municipal, 5; private, 12.
Private: Baltic, Danielson, Fairfield.

DELAWARE: Municipal, 1; private, 0.
Municipal: Milford.

DISTRICT OF COLUMBIA: Municipal, 1; private, 0.

FLORIDA: Municipal, 1; private, 0.

GEORGIA: Municipal, 6; private 1; not stated, 1.
Municipal: Pelham. **Private:** Brunswick.

IDADO: Municipal, 3; private, 1.
Municipal: Burley, Preston, Twin Falls. **Private:** Boise.

ILLINOIS: Municipal, 19; private, 1; not stated, 1.
Municipal: Hillsboro, Hoopeston, Jacksonville, Johnston City, Mt. Olive, Olney, Princeton, White Hall.

INDIANA: Municipal, 23; private, 6; not stated, 1.
Municipal: Gas City, Delphi, Knightstown, Linton, Logansport, Veedersburg, Whiting. **Private:** Nappanee, Seymour.

IOWA: Municipal, 22; private, 2; not stated, 2.
Municipal: Cherokee, Eagle Grove, Indianola, Knoxville, Maquoketa, Missouri Valley, Mt. Pleasant, New Hampton, Osceola, Stanton, Vinton. **Private:** Marion.
KANSAS: Municipal, 16; private, 1; not stated, 1.
Municipal: Abilene, Columbus, Eureka, Fort Scott, Galena, Hiawatha, Humboldt, Mulberry, Paola.
KENTUCKY: Municipal, 5; private, 4.
Municipal: Fulton. **Private:** Georgetown.
LOUISIANA: Municipal, 6; private, 0.
Municipal: Donaldsonville, Kentwood, Morgan City, Rayne.
MAINE: Municipal, 7; private, 6.
Municipal: Bangor, Dexter, Jay, Madison, Van Buren. **Private:** Warren.
MARYLAND: Municipal, 7; private, 0.
Municipal: Chestertown, Frostburg.
MASSACHUSETTS: Municipal, 45; private, 4; not stated, 2.
Municipal: Adams, Clinton, Dalton, North Attleboro, Somerset, Westboro, Wrentham. **Private:** Whitinsville.
MICHIGAN: Municipal, 30; private, 0.
Municipal: Crystal Falls, Durand, Escanaba, Hastings, Hancock, Houghton, Marquette, Muskegon Heights, Paw-Paw,
MINNESOTA: Municipal, 17; private, 0; not stated, 1.
Municipal: Aurora, Lake City, Little Falls, New Ulm, Pipestone.
MISSISSIPPI: Municipal, 5; private, 0; not stated, 1.
Municipal: Brookhaven, Canton, Winona.
MISSOURI: Municipal, 8; private, 3.
Municipal: Fredericktown, Trenton.
MONTANA: Municipal, 6; private, 0.
Municipal: Havre, Miles City, Missoula.
NEBRASKA: Municipal, 9; private, 0.
Municipal: Chadron, Holdrege, Lincoln.
NEW HAMPSHIRE: Municipal, 8; private, 1.
Municipal: Pembroke, Somersworth. **Private:** Walpole.
NEW JERSEY: Municipal, 11; private, 5; not stated, 1.
Municipal: Glassboro, Highland Park, Woodstown. **Private:** Helmetta, Jamesburg, Washington.
NEW YORK: Municipal, 35; private, 1; not stated, 2.
Municipal: Albion, Canton, E. Syracuse, Frankfort, Le Roy, Malone, St. Johnsville, Sidney, Waterville, Wellsville.
NORTH CAROLINA: Municipal, 12; private, 0.
Municipal: Henderson, Mooresville, Newton, Troy.
NORTH DAKOTA: Municipal, 2; private, 0.
Municipal: Grand Forks.
OHIO: Municipal, 33; private, 8; not stated, 2.
Municipal: Barnesville, Bucyrus, Conneaut, Eaton, Gibsonburg, Elyria, Leetonia, Marietta, Middletown, Milan, Montpelier, Sidney, Willard. **Private:** Chillicothe, Mt. Gilead, Shelby, Uhrichsville.
OKLAHOMA: Municipal, 8; private, 0; not stated, 1.
Municipal: Collinsville, Guthrie, Hominy, Kingfisher, Pawhuska.
OREGON: Municipal, 4; private, 1; not stated, 1.
Municipal: Corvallis, Newberg. **Private:** Marshfield.
PENNSYLVANIA: Municipal, 18; private, 25.
Municipal: Alequippa, Catasauqua, Danville, Juniata, Kutztown, Lebanon. **Private:** Freeport, McDonald, Midland, Millville Millersburg, Myersdale, Pottsville, Susquehanna, Wellsboro.
RHODE ISLAND: Municipal, 2; private, 2.
SOUTH CAROLINA: Municipal, 9; private, 1.
Municipal: Cheraw, Dillon, Spartanburg. **Private:** Darlington.
SOUTH DAKOTA: Municipal, 1; private, 1; not stated, 1. **Private:** Lead.
TENNESSEE: Municipal, 7; private, 3.
Municipal: Kingsport, Maryville. **Private:** Elizabethtown.
TEXAS: Municipal, 11; private, 4; not stated, 3.
Municipal: Seguin. **Private:** Orange, San Benito.
UTAH: Municipal, 2; private, 0.
Municipal: Ogden.
VERMONT: Municipal, 7; private, 0.
Municipal: Northfield, St. Johnsbury, Winooski.
VIRGINIA: Municipal, 5; private, 0.
Municipal: Marion.
WASHINGTON: Municipal, 11; private, 3.
Municipal: Bellingham, Ritzville, Cle Elum, Walla Walla. **Private:** Hoquiam, So. Bend.
WEST VIRGINIA: Municipal, 1; private, 3.
Municipal: Sisterville. **Private:** Keyser.
WISCONSIN: Municipal, 31; private, 2; not stated, 3.
Municipal: Lancaster, Manitowoc, So. Milwaukee, Two Rivers, Waupaca, Wausau, West Allis.
CANADA: Municipal, 21; private, 1.
Municipal: Belleville, Ont.; New Westminster, B. C.; Grandy, Que.; Niagara Falls, Ont.; Halifax, N. S.; Hawkesbury, Ont.; Sidney Mines, N. S.; Joliette, Que.; Victoria, B. C.; St. Boniface, Man.; Stratford, Ont. Truro, N. S. **Private:** Walkerville, Ont.

Total—Municipal, 499; private, 109.

Total C. I. Mains in Use

State and City	Under 6-inch	6", 8", 10" and 12"	Over 12-inch
Alabama:			
Gadsden	.....	36 mi.	.....
Union Springs	80,000	40,000	.....
Arkansas:			
Arkadelphia	10,500	11,270	.....
Harrison	38,500	7,000	.....
Nashville	16,000	20,000	.....
Rogers	34 mi.	.....	.....
West Helena	5,300	.....	.....
Arizona:			
Glendale	7,000	16,000	.....
Tucson	96,328	158,354	18,800
California:			
Lodi	10,000	30,000	.....
Modesto	115,900	66,000	.....
Monterey Park	46,375	17,985	.....
National City	62,492	33,117	.....
Redlands	.....	9,000	.....
Salinas	54,034	19,687	.....
Sacramento	52,934	883,976	27,057
San Buena Ventura	109,478	52,860	2,500
San Jose	513,970	229,427	18,902
Colorado:			
Alamosa	.....	17,000	.....
Colorado Springs	287,000	285,000	103,000
Greeley	50,321	58,293	.....
Montrose	55,000	14,000	.....
Pueblo	83,706	265,088	38,172
Connecticut:			
Ansonia	45,850	116,453	14,521
Baltic	6,378	10,446	1,640
Bridgeport	56,148	1,411,903	300,629
Bristol	69,400	209,022	13,993
Darien	9,082	94,067	.....
Farmington	.....	35,000	.....
Hartford	29,984	1,065,390	292,702
Rockville	.....	66,028	.....
Shelton	28,913	52,227	25,950
Southington	24,120	144,523	.....
So. Manchester	125,724	73,273	10,176
Stonington	40,085	91,825	.....
Westport	56,622	127,379	15,507
District of Columbia:			
Washington	248,366	3,180,108	438,183
Florida:			
Lakeland	40,800	126,400	.....
Georgia:			
Cedartown	20,687	23,585	.....
Sandersville	.....	4 mi.	.....
Thomasville	.....	80,540	.....
Idaho:			
Twin Falls	.....	50,000a	.....
Illinois:			
Bloomington	.....	56 mi.a	.....
Freeport	93,498	194,112	3,646
Harvey	.....	223,196	12,498
Hillsboro	10,780	26,000	7,920
Hoopeston	35 mi.	2 mi.	.....
Johnston City	15 mi.	10 mi.	.....
Lake Forest	22 mi.a	.....	.....
Mattoon	.....	3½	.....
Morrison	15 mi.	1,000	.....
Mt. Olive	4 mi.	6 mi.	.....
Olney	47,520	42,240	.....
Oak Park	136,485	375,719	11,997
Princeton	80,700	7,800	.....
Quincy	8,045	455,293	24,425
Springfield	59,374	640,474	68,741
West Chicago	930	67,504	.....
Indiana:			
Attica	43,460	20,800	.....
Auburn	45,760	25,048	600
Cambridge City	8 mi.	300	.....
Connersville	67,127	90,556	1,632
Delphi	25,413	2,022	.....
Elkhart	11,743	8,885	12,610
Fort Wayne	77,000	1,016,100	43,000
Gas City	1,800	10,000	.....
Goshen	29,687	133,367	1,200
Jasper	20,330	5,000	.....
Kendallville	36,430	29,500	.....
Knightstown	20,500	9,000	.....
Lafayette	67,367	265,064	19,396
Logansport	55 mi.	.....	.....
Marion	28,828	230,880	2,798
Martinsville	35,000	25,000	.....
Michigan City	17,398	190,163	27,796
Muncie	.....	210,145	10,564
Mishawaka	43,633	210,658	12,307
Nappanee	.....	2,540	.....
Peru	650	55,000	8,200
Princeton	38,422	67,541	.....
Seymour	84,869a	.....	.....
South Bend	35,892	1,052,950	36,675
Veedersburg	5,000	7,000	.....
Whiting	.....	80,600	500
Iowa:			
Boone	91,199	95,906	20,000
Burlington	45,193	295,706	4,399
Cedar Rapids	6.18 mi.	97.67 mi.	5.18 mi.
Charles City	102,474	29,700	.....
Cherokee	.....	14 mi.	.....

Cast Iron Pipe Laid in 1926

State and City	Under 6-inch	6", 8", 10" and 12"	Over 12-inch
Iowa (Continued)			
Cresco	40,000	4,800	.....
Dubuque	31,309	449,539	28,044
Eagle Grove	40,000	11,500	500
Fort Dodge	49,293	223,623	3,131
Knoxville	21,250	13,010	4,100
Maquoketa	4,450	60,650	.....
Marion	29,435	23,000	.....
Mason City	240,000	120,000	.....
Missouri Valley	33,500	5,050	.....
New Hampton	40,000	1,700	.....
Osceola	.....	3 mi.	.....
Sioux City	580,300	105,000	.....
Washington	50,500	26,050	.....
Kansas:			
Augusta	8,400	7,200	.....
Coffeyville	119,102	32,940	12,740
Columbus	1 mi.	2 mi.	.....
Eureka	40,450	17,300	.....
Hiawatha	10 mi.	8 mi.	.....
Humboldt	.....	12,000	.....
Hutchinson	3.02 mi.	62.22 mi.	.....
Independence	25 mi.a	.....	.....
Junction City	79,600	50,200	.....
Kansas City	115,696	754,649	131,194
Leavenworth	42,400	95,040	73,920
Lawrence	70,000	109,120	16,500
Mulberry	5,350	1,000	.....
Newton	38,544	196,354	.....
Paola	15,000	50,000	.....
Kentucky:			
Ashland	12,895	213,461	.....
Covington	30 mi.	45 mi.	10 mi.
Georgetown	46,000	7,200	.....
Hopkinsville	20,418	50,911	.....
Louisville	323,334	3,097,377	392,835
Somerset	.....	27,582	6,608
Louisiana:			
Donaldsville	.....	5¼ mi.	.....
Jennings	3,800	20,200	.....
Kentwood	3,500	12,000	.....
Rayne	.....	30,088	.....
Ruston	38,200	12,500	.....
Maine:			
Augusta	2,402	188,105	62,377
Biddeford	130,514	391,897	51,752
Calais	70,000	14,455	.....
Houlton	8,669	59,117	.....
Madison	.....	28,000	35,000
Norway	8,000	20,000	.....
Portland	634,073	918,934	255,373
Van Buren	.....	11½ mi.	.....
Warren	.....	3½ mi.	.....
Maryland:			
Baltimore	248.2 mi.	825.3 mi.	151.0 mi.
Chestertown	.....	5 mi.	.....
Frostburg	21,120	26,400	.....
Hagerstown	.....	64 mi.	.....
Pocomoke City	10,000	6,000	.....
Salisbury	29,200	52,200	2,400
Wash. Sub. San. Dist.	109,836	783,103	66,885
Massachusetts:			
Adams	26 mi.a	.....	.....
Andover	61.87 mi.a	.....	.....
Belmont	.....	252,817	.....
Brockton	.....	596,148	112,486
Concord	65,807	174,677	22,635
Dracut	1,500	8 mi.	.....
Dudley	.....	10.3 mi.	.....
Everett	29,190	.....	26,686
Falmouth	16,183	.....	.....
Framingham	.....	63.2 mi.	.....
Greenfield	65,177	198,412	.....
Haverhill	192,005	418,432	50,072
Leominster	37,684	283,584	17,523
Lowell	860,150	55,165	.....
Lexington	27,890	214,645	.....
Malden	27,265	410,151	20,009
Medford	26,880	414,200	17,046
Milford	47,914	144,988	21,611
Milton	22,370	323,505	3,459
Millbury	800	65,042	6,484
New Bedford	38,515	787,242	198,570
North Adams	267,166a	.....	.....
Northampton	114,185	263,018	75,707
Rochford	2,584	78,091	.....
Shrewsbury	7,366	79,200	.....
Somerville	21,404	400,167	21,946
South Hadley Falls	.....	15,000	.....
Spencer	8,385	21,515	7,410
Swampscott	106,259	20,103	10,435
Springfield	62,924	1,046,861	198,046
Taunton	40,057	449,078	39,594
Wareham	18,000	48,000	.....
Wakefield	.....	10 mi.	.....
Whitinsville	27,024	58,823	7,798
Waltham	11,980	75.2 mi.	.....
Williamstown	37,329	109,992	.....
Winthrop	.....	33 mi.	.....
Warren	.....	37,062	.....
Wrentham	.....	7.7 mi.	.....
Michigan:			
Albion	75,300	43,300	.....
Ann Arbor	281,192	353,546	50,501
Benton Harbor	105,600	112,000	5,000
Coldwater	73,513	64,718	325
Detroit	899,958	9,215,417	1,061,607
Durand	7.9 mi.a	.....	.....
Hancock	7,500	32,000	.....
Hastings	19.9 mi.	.....	.....
Holland	23,179	179,431	365
Houghton	33,001	30,800	.....
Ironwood	31,971	109,976	32,180
Jackson	110,000	675,200	14,475
Kalamazoo	177,000	451,000	8,000
Ludington	.....	125,000	.....
Marquette	87,097	70,392	1,485
Mt. Clemens	.....	190,080	.....
Niles	58,044	86,438	.....
Otsego	20,000	10,000	800
Paw Paw	5,000	26,600	.....
Petoskey	16 mi.a	.....	.....
Rochester	12,500	71,100	.....
Yale	16,000	5,000	.....
Minnesota:			
Anoka	.....	10.3 mi.	.....
Aurora	6,400	18,000	.....
Bemidji	20,128	29,284	.....
Cloquet	6,308	87,434	.....
Duluth	13,949	1,026,616	116,566
Hibbing	52,891	178,260	16,704
Lake City	14 mi.	12 mi.	.....
Little Falls	.....	45,073	.....
Luverne	49,820	4,900	.....
Melrose	15,000a	.....	.....
Minneapolis	2,422,576	1,111,192	342,815
Rochester	66,958	85,878	20,092
St. Peter	.....	24,473	.....
Stillwater	7,055	102,321	683
Willmar	69,530	9,835	.....
Mississippi:			
Brookhaven	.....	6 mi.	.....
Canton	7,400	37,400	.....
Jackson	260,000	56,000	4,100
Vicksburg	1½ mi.	33 mi.	3.2 mi.
Winona	15,500	23,200	.....
Missouri:			
Chillicothe	14,000	100,000	.....
Clinton	40,000	20,000	.....
Columbia	60 mi.a	.....	.....
Excelsior Springs	73,101	44,476	.....
Fulton	4 mi.	2 mi.	.....
Jefferson City	25,413	89,735	3,775
Marshall	2,300	11,500	.....
West Plains	15,000	17,000	.....
Montana:			
Billings	40,537	199,615	12,054
Great Falls	10,079	277,274	11,798
Havre	9,082	48,872	.....
Kalispell	3,382	67,625	4,478
Missoula	.....	.....	1,000
Nebraska:			
Fremont	30 mi.	3 mi.	.....
Grand Island	.....	34 mi.	3,000
Hastings	22 mi.	20 mi.	1 mi.
Omaha	144,187	2,191,678	277,139
Superior	26,600	25,200	.....
New Hampshire:			
Claremont	6,000	95,500	7,400
Franklin	1,500	70,352	.....
Keene	66,977	198,608	6,330
Lebanon	.....	20,389	.....
Manchester	23,761	726,735	96,609
Newport	5,132	104,154	.....
Somersworth	7,147	68,013	2,066
Walpole	7,920	10,560	.....
New Jersey:			
Dover	147,917	28,136	.....
Glassboro	5 mi.	16 mi.	.....
Hightstown	31,000	12,000	.....
Helmetta	500	7,680	.....
Irvington	6,951	292,318	13,200
Jamesburg	2,300	1,200	.....
Montclair	49,294	425,295	17,236
Nutley	38,000	186,400	.....
Red Bank	138,601	46,200	.....
Verona	.....	105,412	.....
Woodstown	.....	20,000	.....
New Mexico:			
Deming	.....	12,400	.....
Tucuncari	46,000	16,900	.....
New York:			
Albany	6,000	100,000	.....
Auburn	.....	378,630	3,149
Beacon	2,200	31,000	.....
Binghamton	60,896	486,000	97,000
Catskill	6 mi.	12 mi.	.....
Dansville	15,600	69,450	.....
Elmira	20,367	553,762	41,349
Frankfort	4,340	6,829	4,987
Geneva	18,476	179,719	18,285
Gloversville	.....	48.1 mi.a	.....
Hoosick Falls	.....	15 mi.	.....
Le Roy	3,000	40,000	31,680
Lowville	900	23 mi.	.....
Malone	20 mi.	16 mi.	.....
Newburgh	67,076	265,274	35,278
Olean	35 mi.	30 mi.	7 mi.

Don't handle with care!

Traffic may pound this pavement of TEXACO Asphalt for years. But it will survive all punishment and require minimum repairs because it is resilient—it will absorb traffic impact.

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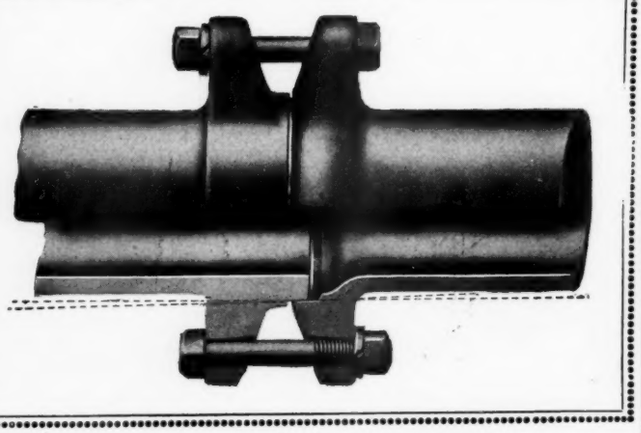
EVER LOOK INTO UNIVERSAL PIPE? IT'S THE ONLY CAST IRON PIPE THAT ELIMINATES ALL JOINTING MATERIALS AND EQUIPMENT . . .

It makes its own joints: Easier to lay: Quicker to lay. No bell holes to dig: No pouring, No joints to calk. Nothing in the joints to work loose or to deteriorate.



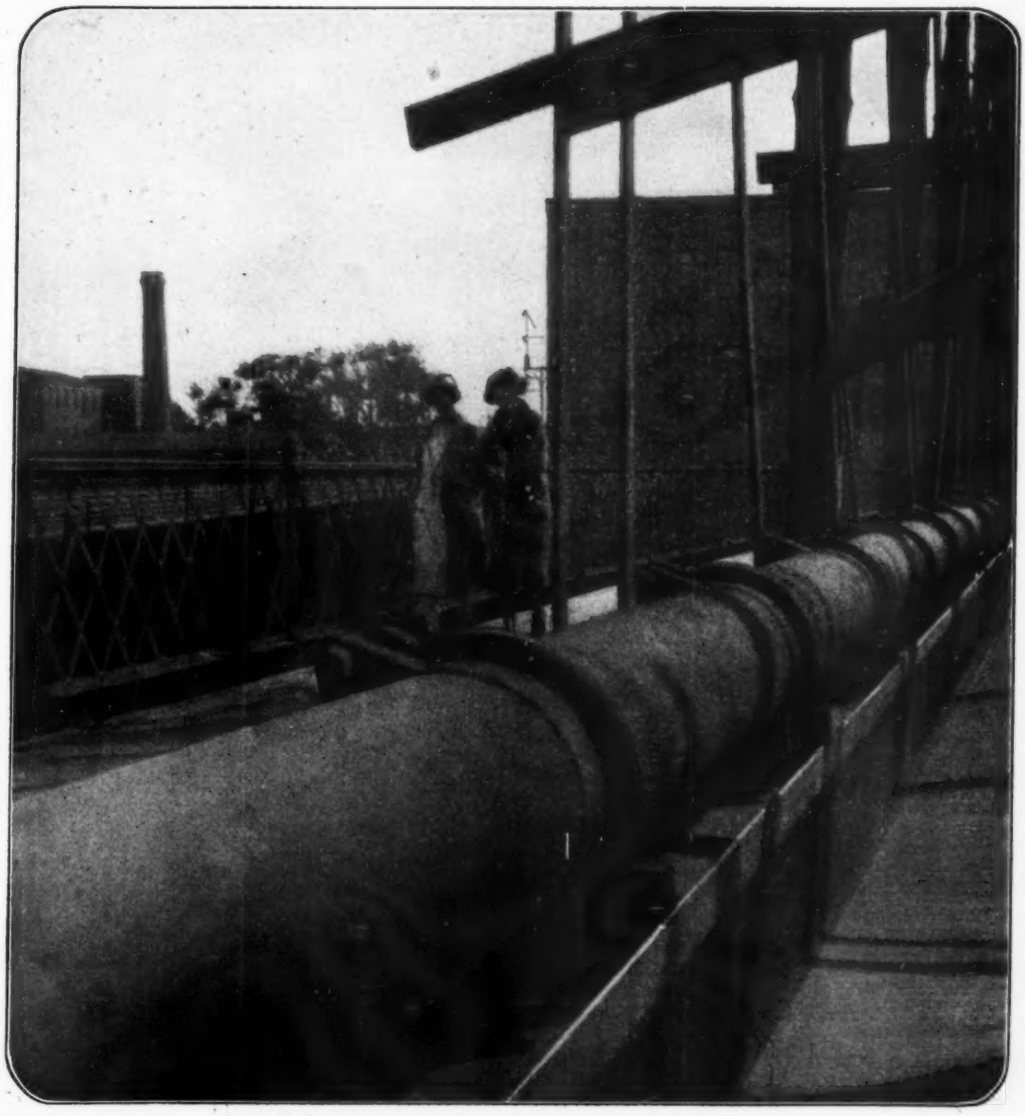
. . JOINTS AS TIGHT AS THE WALL OF THE PIPE ITSELF . .

A PIPE INSTALLATION without any joints, if such a thing were possible, would be ideal.

The nearest approach to a jointless line is a Universal Cast Iron Pipe line because the JOINTS as well as the PIPE are all CAST IRON.

No lead nor any other jointing material is necessary—nothing in the joints to work loose, nothing to blow out.

The hub and spigot ends of Universal Cast Iron Pipe, machine-tapered at slightly different angles, are drawn into direct contact forming flexible iron-to-iron joints that amply provide for expansion and contraction, vibration and uneven ground settlement.



. . . The very nature of its joint construction recommends Universal Cast Iron Pipe as a safe pipe, many authorities say "the only safe pipe" for bridge and river crossings. Its machined iron-to-iron joints remain unaffected by jar, vibration and exposure to the elements.

. . JOINTS AS TIGHT AS THE WALL OF THE PIPE ITSELF . .

Thousands of miles installed the country over every year, much of it by common labor.

Flexible, dependable, safe—*joints as tight as the wall of the pipe.* Wrenches the only tools.

Put your water supply, fire protection and sewage disposal problems up to us. Our nearest office is at your service.

Easily laid anywhere in any season, up hill and down, in rock, in sand, in narrow trenches—wet or dry, on bridges and under water.

Universal Pipe saves all along the line. It is a sure safeguard against costly replacements and a positive protection against the risk and waste of leakage.

UNIVERSAL CAST IRON PIPE

No bell holes to dig: No joints to calk

THE CENTRAL FOUNDRY COMPANY

Subsidiary of The Universal Pipe and Radiator Company

Graybar Building, 420 Lexington Avenue

Chicago Birmingham New York Dallas San Francisco

PHOTOGRAPH *showing part of a cast iron pipe installation at Chicago, Illinois.*

UNITED STATES CAST IRON PIPE & FOUNDRY CO.
Makers of
deLavaud
Centrifugal Cast Iron Pipe
PATENTED

Standard Bell and Spigot can be laid easily

even under the most unusual conditions

THE cast iron pipe illustrated here passes through an *unlined* rock tunnel.

The strength of Cast Iron Pipe makes this type of installation possible. The accessibility of lines laid in this manner will be quickly appreciated by engineers.

Contractors have long been aware of the ease of standard Cast Iron Pipe installations and can make their bids accordingly.

We maintain a special Service Department for the assistance of contractors and construction engineers. Information about it will be sent to you gladly—write for details, there is no obligation involved.

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Minneapolis: 6th St. & Hennepin Ave.

Excavating through 18 inches of frost

Digging sewer through 18 inches of frost at Greenbay and Hampton Roads, Wis. Owned by H. Teget, Milwaukee, Wis.

Any Trencher without THREE bucket line speeds is obsolete

A trenching machine is nothing more or less than a cutting tool. When you are in hard digging you need LESS SPEED and MORE POWER. When you are in easy digging you need LESS POWER and MORE SPEED.

A trencher with only one bucket line speed is hardly ever satisfactory. It is either not fast enough or not powerful enough for the job at hand.

The P&H is the only large size trencher built with *Three Bucket Line Speeds Suitable for Every Condition of Digging.*

This is just another of the many reasons why the P&H digs at a *Lower Cost Per Foot Than Any Other Trencher Made.*

Speed Assuring Features

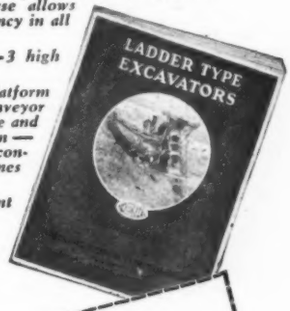
Powerful crowd when needed. Attachment is independent and may be disconnected when necessary.

Three Bucket Line Speeds without sprocket change and one reverse allows operation at full efficiency in all soils.

Corduroy traction—3 high traction speeds.

Dual control from platform on either side—spoil conveyor operating on either side and at any desired elevation—these features provide convenient control at all times by one operator.

Safety clutch at point of shock.



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New York, Philadelphia, Birmingham, Chicago, Kansas City, San Francisco, Indianapolis, Charlotte, Detroit, Dallas, St. Louis, Pittsburgh, Portland, Memphis, Los Angeles, Seattle, Jacksonville, Minneapolis, Atlanta, Tampa, Miami

WAREHOUSES AND SERVICE STATIONS
Philadelphia, Memphis, Jacksonville, San Francisco, Los Angeles, Seattle

P&H TRENCH EXCAVATORS

Every time a community pays for *one* brick pavement it *gets two!*

One side of the brick, properly laid, will give twenty-five to thirty-five years of service, at least. Then, even if the foundation should fail, *the other side* is ready for just as many more years of resistance to traffic.

Scores of far-sighted communities are saving taxes in this way by using vitrified brick, asphalt-filled. Write for facts and figures from official public records proving the salvage value of brick pavements.

No one who voted for Grover Cleveland on his second election for President is less than 56 years old. And yet torch-light processions of that presidential campaign (1892) marched on brick pavements which are still in use today.

Keep this in mind when your community is called upon to decide on paving materials.

Advocate

VITRIFIED
Brick
PAVEMENTS

OUTLAST THE BONDS

NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION ENGINEERS BLDG. CLEVELAND, O.

State and City	Under 6-inch	6", 8", 10" and 12"	Over 12-inch
New York (Continued)			
Oneonta	4 mi.	23 mi.	¾ mi.
Ossining	10 mi.	69,499	5,678
Oswego	154,877	261,183	17,700
Penn Yan	.....	8,870	.....
St. Johnsville	2,000	16,000	.....
Sidney	.....	15 mi.	.....
Scarsdale	11,960	306,284	14,200
Utica	118,252	938,166	81,849
Waterford	22,000	38,000	.....
Wellsville	47,800	8,572	2,550
North Carolina:			
Gastonia	6,690	179,050	20,637
Greensboro	85,000	432,138	42,628
Henderson	2,000	60,000	.....
Kings Mountain	11,356	65,682	2,200
Kinston	10,050	78,520	.....
Mooresville	30,000	30,000	.....
Newton	35,000	40,000	.....
Raleigh	4,650	386,971	26,328
Rocky Mount	18,866	119,203	.....
Statesville	75,000	17,000	25,000
Wilmington	28,740	199,050	16,750
North Dakota:			
Fargo	21,403	264,537	18,223
Grand Forks	4,940	115,359	15,932
Ohio:			
Akron	22.9 mi.	350.8 mi.	37.1 mi.
Barberton	28,600	94,000	24,000
Barnesville	40,000	20,000	90,000
Bedford	10,000	227,600	.....
Bowling Green	44,389	55,065	.....
Bucyrus	.....	8,200	.....
Cincinnati	1,200,310	3,070,850	639,223
Conneaut	29,490	99,229	1,882
Columbus	157,807	1,989,135	279,739
Defiance	13,800	106,500	7,000
Dennison	26.8 mi.	.....	300
Eaton	8,262	40,000	.....
East Cleveland	13,152	255,173	30,665
Elyria	33 mi.	37 mi.	3 mi.
Gibsonburg	15,300	31,500	.....
Kent	18,500	86,500	.....
Lakewood	49,600	465,256	24,400
Lancaster	72,707	80,568	4,225
Middletown	15,000	280,000	5,000
Montpelier	25,000	15,000	.....
Mt. Gilead	6 mi.a	.....	.....
Orrville	30,010	54,140	.....
Sidney	41,400	78,000	.....
Struthers	.....	71,907	25,463
Warren	22,807	451,460	7,241
Youngstown	30,000	1,500,000	63,000
Oklahoma:			
Blackwell	20,000	25,000	.....
Hominy	32,500	17,600	.....
Mangum	25 mi.	.....	.....
Pawhuska	58,800	11,100	.....
Stillwater	10 mi.	1 mi.	.....
Oregon:			
Newberg	.....	5,200	.....
Marshfield	161,000a	.....	.....
The Dalles	.....	10,000	.....
Pennsylvania:			
Allentown	108 mi.a	.....	.....
Ashland	5 mi.a	.....	.....
Bradford	.....	32 mi.	6 mi.
Catasaqua	5,618	22,060	4,002
Clearfield	74,132	58,392	525
Coatesville	13,728	112,992	5,808
Connellsville	25 mi.	23 mi.	6 mi.
Corry	.....	25 mi.	3 mi.
Duquesne	.....	.....	6,000
Frackville	9⅔ mi.a	.....	.....
Freeport	32,100	13,000	.....
Huntingdon	64,500	20,000	.....
Jersey Shore	69,203	27,100	.....
Lancaster	375,742a	.....	.....
Lebanon	63,599	142,868	72,789
Lehighton	44,400	87,900	1,400
McDonald	21,379	53,714	.....
Midland	11,000	32,115	.....
Millville	.....	1 mi.	.....
Mt. Carmel	52,727	41,903	108
Myersdale	7 mi.	.....	.....
Northampton	55 mi.a	.....	.....
Phoenixville	10,000	70,000	5,000
Pottsville	34,902	239,234	160,006
Reading	48,276	509,880	120,702
Reynoldsville	402,240	10,780	.....
Schuylkill Haven	65,840	32,000	.....
Shamokin	77,079	198,860	151,180
Sharpsvile	3 mi.	2 mi.	.....
Summit Hill	18,322	11,547	.....
Wilkinsburg	172,654	767,805	132,390
Woodlawn	43,377	77,905	5,858
York	.....	587,242	.....
Rhode Island:			
E. Providence	20,519	182,943	4,089
So. Kingstown	30,902	80,516	.....
Westerly	.....	46.8 mi.	.....
Woonsocket	33,580	268,000	86,000
South Carolina:			
Charleston	58,734	374,751	155,733
Cheraw	20,000	25,000	.....
Darlington	2½ mi.	7 mi.	.....
Dillon	13,000	34,000	.....
Easley	2,000	53,500	.....
Rock Hill	10 mi.	8 mi.	.....
Spartanburg	187,825	350,673	98,237
South Dakota:			
Brookings	12,570	30,215	.....
Lead	23,794	24,806	.....
Mitchell	79,010	57,260	.....
Tennessee:			
Clarksville	16.5 mi.a	.....	.....
Dyersburg	.....	75,000	.....
Elizabethtown	40 mi.a	.....	.....
Fayetteville	3,000	19 mi.	.....
Kingsport	26,000	62,000	.....
Memphis	147,852	325 mi.	139,613
Milan	8 mi.	3½ mi.	.....
Shelbyville	15,000	10,500	.....
Texas:			
Big Spring	35,000	30,000	.....
Childress	15 mi.	15 mi.	.....
Dallas	39.8 mi.	214.1 mi.	25.2 mi.
El Paso	66,500	330,000	87,500
Ennis	16,000	20,000	.....
Graham	7 mi.	15 mi.	.....
Greenville	.....	400	1½ mi.
Mexia	.....	27,450	.....
Orange	26,400	50,160	.....
San Antonio	283.5 mi.a	.....	.....
San Benito	23,000	28,000	.....
Tyler	35,734	117,435	18,235
Weatherford	36,738	10,050	.....
Waco	17,746	486,881	61,272
Wichita Falls	94,484	324,258	37,008
Utah:			
Ogden City	1,372	22,850	2,437
Tooele	3,700	.....	.....
Vermont:			
Brattleboro	26,280	63,360	49,264
Newport	14 mi.a	.....	.....
Northfield	48,125	.....	.....
Rutland	.....	230,000	.....
Winooski	.....	9.7a	.....
Virginia:			
Charlottesville	.....	25 mi.	.....
Danville	27,389	136,690	14,531
Martinsville	20,600	15,000	.....
Newport News	162,227	304,355	.....
Washington:			
Aberdeen	5 mi.	14 mi.	10 mi.
Centralia	.....	900	700
Hoquiam	40½a	.....	.....
Pullman	30,000	25,000	.....
Ritzville	3,000	15,000	.....
Spokane	21,651	638,072	32,885
Tacoma	82,553	619,915	67,982
Walla Walla	.....	78½ mi.a	.....
Winloch	1,000	500	.....
Yakima	11,606	63,349	1,223
West Virginia:			
Beckley	.....	53,000	.....
Keyser	700	4½ mi.	600
Morgantown	73,000	73,750	.....
Sisterville	27,000	11,500	.....
Wellsburg	.....	11½ mi.	.....
Wisconsin:			
Algoma	14,276	18,000	.....
Appleton	91,369	249,530	4,912
Ashland	24,397	141,355	9,757
Baraboo	4,773	81,563	.....
Fond du Lac	46,505	192,803	9,757
Fort Atkinson	51,393	38,710	.....
Green Bay	8,023	299,731	5,707
Hartford	.....	1,920	.....
Janesville	41,227	221,063	9,797
Jefferson	39,057	19,381	.....
Kaukauna	10,067	70,816	120
La Crosse	7,619	390,328	40,045
Ladysmith	22,916	24,540	.....
Lancaster	30,005	32,334	.....
Madison	1,279	16,647	.....
Marinette	69,340	134,560	6,150
Menasha	15,726	91,373	2,820
Milwaukee	21,100	3,269,970	363,482
Neenah	14,000	90,482	5,292
Oconomowoc	32,709	44,624	6,345
Port Washington	22,090	36,000	.....
Reedsburg	4,163	80,440	.....
Richland Center	30,250	21,532	.....
Shawano	25,813	50,133	.....
South Milwaukee	.....	22 mi.	.....
Sturgeon Bay	1,394	20,305	17,700
Two Rivers	49,116	51,562	700
Watertown	26,514	127,334	3,423
Waupaca	25,100	25,329	.....
Wausau	51,664	218,979	21,565
Wisconsin Rapids	5,800	105,000	.....
Canada:			
Charlottetown, P. E. I.	17,400	90,000	16,000
Grandy, Que.	9 mi.	6 mi.	2 mi.
Guelph, Ont.	155,640	26,700	3,150
Halifax, N. S.	65,010	315,683	112,210

State and City	Under 6-inch	6", 8", 10" and 12"	Over 12-inch
Canada (Continued)			
Hamilton, Ont.	41,478	975,698	161,294
Hawkesbury, Ont.	.....	41,400	.....
Joliette, Que.	21,850	42,195	400
Kitchener, Ont.	94,806	191,097	.....
New Westminster, B. C.	.....	95 mi.a	.....
Niagara Falls, Ont.	.....	42 mi.a	.....
Orillia, Ont.	40,325	61,225	2,700
St. Boniface, Man.	11,000	15,400	.....
St. Catherine's, Ont.	106,490	213,926	62,050
St. Thomas, Ont.	10 mi.	21 mi.	4 mi.
Toronto, Ont.	90,850	3,189,807	293,970
Victoria, B. C.	229,884	199,924	.....
Walkerville, Ont.	71,089	375,923	.....
Winnipeg, Man.	71,189	1,384,503	111,750

a—All sizes.

Steel Pipe Laid in 1926 and Total in Use

State and City	12 inch and Smaller: Laid in 1926 Feet	12 inch and Smaller: Total in Use Feet	Larger than 12 Inch: Laid in 1926 Feet	Larger than 12 Inch: Total in Use Feet
Arizona:				
Glendale	..	1,400	.....	.....
California:				
Chula Vista—Included in National City				
Dinuba	1,400	70,280	.....	.....
National City	.....	.....	3,856	59,210
Redlands	.....	620,000a	.....	.....
Salinas	6,079	75,564	.....	682
San Buena Ventura	.....	.....	.....	36,175
Sacramento	.....	.....	.....	67,196
San Jose	36,056	770,115	3,697	110,412
Santa Barbara	.....	.....	7,415	.....
Upland	8 mi.	25 mi.	.....	.....
Colorado:				
Alamosa	.....	150,000	.....	.....
Colorado Springs	.....	.....	.....	119,400
Greeley	2,266	62,691	.....	10,390
Montrose	.....	74,000	.....	.....
Idaho:				
Boise	350	249,930	.....	.....
Illinois:				
Quincy	.....	10,612	.....	.....
Indiana:				
Jasper	300	1,600	.....	.....
Kansas:				
Coffeyville	2,000	10,000	.....	.....
Kansas City	.....	650	3,045	7,957
Paola	5,000	30,000	.....	.....
Maine:				
Bangor	300	61 mi.	.....	.....
Maryland:				
Washington Sn. Dst.	315	43,230	.....	.....
Massachusetts:				
New Bedford	.....	.....	.....	42,381
Springfield	.....	.....	1,185	68,616
Michigan:				
Detroit	.....	.....	74,031	160,839
Holland	.....	2,976	.....	.....
Ironwood	.....	35,879	.....	14,427
Minnesota:				
Aurora	1,450	7,900	.....	.....
Duluth	.....	718	.....	32,781
Hibbing	.....	7,336	.....	24,987
Minneapolis	.....	.....	.....	17 mi.
Missouri:				
Chillicothe	.....	1,800	.....	.....
Clinton	.....	3,000	.....	.....
Montana:				
Billings	.....	11,433	.....	.....
Great Falls	.....	2,251	.....	14,720
Havre	.....	2,300	.....	.....
Kalispell	.....	20,067	.....	.....
Missoula	.....	130,000	.....	16,000
Nebraska:				
Omaha	.....	.....	23,237	33,400
New Hampshire:				
Manchester	.....	.....	.....	128
New Jersey:				
Montclair	.....	.....	.....	7,343
New Mexico:				
Deming	.....	26,100	.....	.....
New York:				
Auburn	.....	1,875	.....	.....
Avon	.....	4,000	.....	.....
Binghamton	.....	.....	.....	95,000
Utica	.....	.....	.....	1,000
Ohio:				
Dennison	.....	.....	.....	150
Elyria	.....	.....	.....	4 mi.
Oklahoma:				
Mangum	.....	2,000	.....	.....
Oregon:				
Corvallis	12,000	.....	23,000	.....
Eugene	4,000	.....	.....	.....
Newberg	30,000	35,000	.....	.....
The Dalles	8 mi.	10 mi.	.....	.....
Pennsylvania:				
Juniata	.....	4,200	.....	.....
Schuylkill Haven	.....	2,000	.....	.....
Wilkinsburg	.....	.....	.....	4,934
Woodlawn	.....	1,100	.....	.....
South Dakota:				
Lead	.....	.....	.....	1,498
Texas:				
Big Spring	.....	10,000	.....	.....
Ennis	.....	10,000	.....	.....
Tyler	5,121	43,286	.....	18,843
Utah:				
Ogden City	8,675	318,874	.....	44,030
Tooele	700	800	.....	.....
Virginia:				
Newport News	668	16,065	.....	.....
Washington:				
Aberdeen	.....	4,500	.....	3,500
Yakima	.....	6,789	2,612	2,612
Centralia	.....	31,040	.....	.....
Spokane	.....	.....	11,058	194,358
Tacoma	.....	3,470	.....	3,025
Walla Walla	710	.....	4,400	.....
West Virginia:				
Morgantown	10,651	193,980	.....	36,680
Wisconsin:				
Green Bay	.....	2,010	.....	.....
Janesville	.....	23,811	.....	.....
Two Rivers	.....	.....	.....	6,126
Canada:				
Belleville, Ont.	2,000	.....	.....	.....
Joliette, Que.	.....	4,250	.....	1,775
St. Thomas, Ont.	.....	.....	.....	8,000
Toronto, Ont.	.....	.....	.....	1 mi. a
Victoria, B. C.	.....	312,000	.....	11,675

a—All sizes.

Other Kinds of Pipes Laid in 1926 and Total in Use

State and City	Kind	Size in Inches	Length Laid-Ft.	Total in Use
Arkansas:				
Arkadelphia	W. I.	2	2,000	18,000
Harrison	W. I.	1¼-2	12,000	.....
West Helena	W. I.	1-6	2,000	84,000
Arizona:				
Bisbee	W. I.	6	250	.....
Glendale	W. I.	¾-2	1,800	24,000
Tucson	W. I.	2-6	23,697	42,570
California:				
Chula Vista—Included in	National City			
Modesto	W. I.	2	2,220	34,320
National City	W. I.	..	556	346,077
Upland	Cement	12	5 mi.	.....
Colorado:				
Colorado Springs	Steel	1½-2	.....	15,000
Greeley	Wood	8-20	.....	31,277
Pueblo	Wood	36	.....	4 mi.
Connecticut:				
Ansonia	W. I.	1½-2	208	12,900
Bristol	W. I.	.....	.....	66,384
Hartford	W. I.	1½-3	.....	6,605
	Vit.	24-48	.....	16,700
	Conc.	24-48	.....	4,646
Rockville	W. I.	2	330	11,987
Shelton	W. I.	.....	.....	11,029
Southington	W. I.	1-2½	1,415	59,000
South Manchester	Wood	18	.....	23,021
Stonington	W. I	1-2	368	166,940
Florida:				
Lakeland	W. I.	2	100,000	515,000

State and City	Kind	Size in Inches	Length Laid-Ft.	Total in Use
Georgia:				
Cartersville	W. I.	1¼-2½	5,000	.....
Cedartown	W. I.	1-4	10,000	43,000
Sandersville	W. I.	.....	600	600
Thomasville	W. I.	.....	.....	60,000
Idaho:				
Boise	Wood	4-10	1,052	113,959
Burley	Wood	4-12	.....	.....
Preston	Wood	4-12	.....	40 mi.
Twin Falls	W. I.	4-24	.....	87,000
Illinois:				
Freeport	W. I.	¾-2	.....	38,994
Morrison	W. I.	¾	500	.....
Olney	W. I.	.....	.....	2,200
Indiana:				
Attica	W. I.	1-2	.....	1,180
Gas City	W. I.	1½	500	500
Knightstown	W. I.	4-10	.....	29,500
Lafayette	C. I.	1¼-2	147	.....
Martinsville	W. I.	1¼-1½	2,000	10,000
Muncie	W. I	2	11,155	157,456
New Albany	W. I.	2	5,060	.....
Nappanee	W. I.	2	3,099	.....
Whiting	W. I.	2-3	.....	3,250
Iowa:				
Knoxville	W. I.	2	3,182	3,182
Marion	W. I.	2	.....	12,325
Sioux City	W. I.	2	25,711	80,550
Kansas:				
Columbus	W. I.	¾	700	.....
Eureka	Steel	2	3,550	47,850
	W. I.	.....	530	530
Humboldt	W. I.	2-3	.....	100,000
Junction City	W. I.	2	1,500	25,000
Kansas City	W. I.	.....	13,049	244,438
Mulberry	W. I.	2	.....	7,008
Kentucky:				
Ashland	W. I.	2	2,699	33,410
Covington	W. I.	.....	700	.....
Glasgow	W. I.	½-1	.....	2,300
Hopkinsville	W. I.	.....	1,771	71,329
Somerset	W. I.	½-4	3,500	64,069
Louisiana:				
Jennings	Copper	¾-1	.....	1,700
	W. I.	1½	.....	1,100
Rayne	Galv.	¾-1½	4,000	.....
Ruston	W. I.	.....	.....	6,300
Maine:				
Bangor	W. I.	1	5,000	.....
Biddeford	W. I.	.....	2,015	.....
Madison	Wood	16	.....	34,442
	W. I.	1-2	.....	18,000
Norway	W I.	1¼-1½	.....	2,000
Warren	W. I.	1	2,000	2,000
Maryland:				
Washington San. Dis.	Wood	4-8	.....	38,525
Massachusetts:				
Cherry Valley	W. I.	2	800	.....
Clinton	W. I.a	2	172	.....
Concord	W. I.	.....	2,219	.....
Danvers	W. I.	1-2	5,966	180,873
Dracut	W. I.	.....	817	6.7 mi.
Falmouth	W. I.	2	2,609	14,427
Fitchburg	W. I.	1-2	1,928	.....
Framingham	W. I.	.....	977	6¾ mi.
Greenfield	W. I.	.....	.....	24,620
Leominister	W. I.	1-2	7,163	250,000
Lexington	W. I.	1-2	10,000	.....
Malden	Cement	4-12	.....	69,616
Milford	W. I.	2-8	553	7,056
Millbury	W. I.	2	400	400
Newburyport	W. I.	.....	552	.....
North Adams	W. I.	¾	2,762	.....
Peabody	Cem. Lin.	1-2	6,000	.....
	Lead Lin.	2-4	300	500
Rockford	W. I.	1-3	.....	42,240
Shrewsbury	W. I.	¾-2	8,465	75,000
Spencer	W. I.,	1½-2	.....	13,570
	Cement	4-14	.....	35,584
Springfield	W. I.,	¾-2	5,527	97,835
	Cement	.....	.....	31,670
Wakefield	Cement	6-12	.....	44
Waltham	W. I., Cem. Lin.	1-1½	13,885	64.8 mi.
Warren	W. I.,	2	200	5,128
Williamstown	W. I.	.....	400	.....
Winthrop	.....	.....	.....	9,258
Michigan:				
Ann Arbor	Copper	¾-1½	1,000	1,000
Niles	W. I.	.....	658	10,226
St. Clair	Kalamein	.....	.....	1½ mi.
Minnesota:				
Duluth	W. I.,	4-12	.....	345
Luverne	Lead	¾	10	800
Red Wing	W. I.	1½-2½	1,655	.....

State and City	Kind	Size in Inches	Length Laid-Ft.	Total in Use
Mississippi:				
Brookhaven	W. I.	.....	1,000	1,500
Vicksburg	W. I.	2	3 mi.	10 mi.
Winona	Brass	.....	.....	10,000
	W. I.	½-2½	.....	6,000
Missouri:				
Jefferson City	W. I.	½-2	3,000	17,565
Marshall	W. I.	2	200	200
Montana:				
Billings	Woodb	6-16	.....	35,259
Great Falls	W. I.	2	.....	2,636
Kalispell	Wood	6-18	.....	25,670
Nebraska:				
Holdredge	.....	4	2,000	.....
Lincoln	W. I.	.....	6.52	160.7
New Hampshire:				
Claremont	Cement	4-12	.....	37,600
Franklin	W. I.	¾-1½	.....	89,965
Keene	Cement	4-16	.....	7,633
Newport	W. I.	1-1¼	600	74,264
Walpole	W. I.	½-¾	.....	2,640
New Jersey:				
Glassboro	W. I.	¾-1¼	3,000	.....
Helmetta	W. I.	1-5	3,000	7,000
Jamesburg	Cement	4-8	.....	23,000
Montclair	W. I.	4	.....	686
Rahway	W. I.	2-3	10,013	.....
Woodstown	.....	3-4	.....	15,000
New York:				
Avon	W. I.	½-¾	200	3,000
Beacon	.....	8-12	.....	34,600
Binghamton	W. I.	1½-2	.....	2,117
Carthage	W. I.	¾-1	500	.....
Dansville	W. I.	1¼-2	.....	1,400
Elmira	W. I.	.....	.....	70,021
Hoosick Falls	W. I.	.....	260	.....
Oneonta	W. I.	.....	.....	100
Utica	W. I.	.....	.....	8,565
Waterford	W. I.	1-2	.....	1,400
	W. I.	2	.....	7,650
Wellsville	Kalamein	.....	.....	22,325
	Wood	16	.....	1,650
North Carolina:				
Gastonia	W. I.	¾-2	11,638	66,805
	C. I.	2	1,558	4,192
Greensboro	W. I.	¾	40,000	300,000
Kinston	W. I.	¾-2	3,000	10,500
Raleigh	W. I.	2	6,736	143,420
Rocky Mount	W. I.	2	2,000	.....
Ohio:				
Bucyrus	Wood	8"	3,000	137,700
Columbus	W. I.	.....	12,780	211,000
Defiance	W. I.	2	1,600	6,000
Lancaster	W. I.	1-2	1,200	8,644
Milan	W. I.	.....	1,000	.....
Orrville	W. I.	1-2	.....	6,400
Struthers	Wood	12	.....	7,800
Oklahoma:				
Pawhuska	W. I.	2	.....	13,900
Oregon:				
Newberg	W. I.	¾-2	2,000	50,000
	Wood	8-10	.....	25,000
The Dalles	Wood	4-14	.....	15 mi.
Pennsylvania:				
Clearfield	W. I.	2	100	7,033
Corry	W. I.	.....	200	2 mi.
McDonald	W. I.	1-3	.....	18,279
Midland	W. I.	2	.....	1,395
Mt. Carmel	W. I.	.....	2,800	.....
	Brass	¾-1	1,200	.....
Schuylkill Haven	W. I.	.....	.....	5,000
Shamokin	W. I.	1½-2	451	10,674
	Brass	¾-1½	13,753	19,641
	Copper	¾-1½		
Rhode Island:				
East Providence	W I	1-2	4,130	77,374
	Steel	2	.....	998
South Kingstown	W. I.	1½-2	.....	9,548
Warwick	W. I.	¾-2	1,790	.....
South Carolina:				
Columbia	W. I.	¾-2½	22,500	14,561
Cheraw	W. I.	.....	.....	25,000
Dillon	.....	.....	1,000	5,000
South Dakota:				
Lead	W. I.	1-12	.....	43,653
Tennessee:				
Erwin	W. I.	.....	1,500	.....
Fayetteville	W. I.	2-4	.....	700
Nashvile	W. I.	.....	656	.....
Texas:				
Childress	W. I.	¾-2	.....	30 mi.
Dallas	W. I. & St.	2c	6,713	87,161
El Paso	W. I & St.	3c	10,000	300,000
Graham	W.I.	.....	.....	10 mi
San Antonio	C. &. W. I.	2"	.....	218.5 mi.

State and City	Kind	Size in Inches	Length Laid-Ft.	Total in Use
Texas (Continued)				
San Benito	W. I. & Ld.	¾-2	.....	49,400
Waco	W. I.	2	7,229	192,101
Utah:				
Ogden City	W. I.	1¼-2	2,981	187,791
Tooele	Galv.	2	600	1,200
Vermont:				
Barton	W. I.	¾-1	2,000	.....
Virginia:				
Charlottesville	W. I.	2-3	7,924	.....
Newport News	W. I.	1-2	20,923	397,649
Washington:				
Aberdeen	W. I.	1-2	18,000	52 mi.
	Wood	6-28	4,000	29 mi.
Clelum	W. I.	.....	1,700	11 mi.
Centralia	W. I.	6	380	380
	Wood	4-12	100	5,600
Dayton	Concrete	12	6,000	.....
South Bend	W. I.	8	.....	2,800
	Wood	6-10	.....	14 mi.
Spokane	Kala.	.....	1,437	1,143,687
	Wood	.....	.....	71,724
Tacoma	W. I.	1-6	9,950	173,161
	Wood	2-24	.....	659,973
Washington (Continued)				
Walla Walla	W. I.	.....	319	.....
Winlock	Wood	4-8	.....	3 mi.
Yakima	Wood	6-12	4,160	122,122
Wisconsin:				
Appleton	W. I.	¾-2	.....	22,943
Ashland	W. I. & Ld.	¾-1	784	17,907
Fond du Lac	W. I.	.....	622	58,954
Green Bay	W. I. & Ld.	¾-3½	3,420	104,906
Kaukauna	W. I.	12	520	520
Ladysmith	W. I.	1½-2½	.....	9,584
Neenah	Lead	1½-2	915	3,000
Reedsburg	W. I.	1½-2	.....	6,550
Waupaca	W. I.	1¼-2	.....	12,205
Canada:				
Hamilton, Ont.	Lead	1-2	.....	27,121
Hawkesbury, Ont.	W. I.	1½-2	.....	600
Kitchener, Ont.	Copper	⅝-1	3,174	.....
	Lead	1½-2	376	.....
St. Catherine, Ont.	W. I.	1-2	8,740	.....
St. Thomas, Ont.	W. I.	.....	1,200	80,000

a—Cement lined; b—and Kalamein; c—and less.

Hydrants and Gate Valves Placed in 1926 and Total in Use

	HYDRANTS		GATE VALVES	
	Placed in 1926	Total in Use	Placed in 1926	Total in Use
Alabama:				
Gadsden	8	240	....	....
Union Springs	....	80	....	15
Arkansas:				
Arkadelphia	....	46	....	40
Harrison	....	83	....	80
Nashville	....	80	72	....
Rogers	....	29	....	84
West Helena	....	35	....	50
Arizona:				
Bisbee	....	110	....	175
Glendale	3	43	3	60
Tucson	15	428	28	529
California:				
Bakersfield	16	300	30	....
Chula Vista—Included in National City				
Dinuba	....	130	....	80
Lodi	....	180	....	50
Modesto	6	283	....	500
National City	10	128	40	....
Redlands	27	597	....	....
Salinas	10	80	30	300
San Buena Ventura	46	....	117	615
Sacramento	39	1,507	92	3,056
San Jose	58	630	415	3,648
Santa Barbara	83	637	....	....
Upland	35	100	50	200
Colorado:				
Alamosa	10	123	10	....
Colorado Springs	9	679	21	2,118
Greeley	8	161	8	299
Montrose	....	70	....	142
Pueblo	75	436	....	691
Connecticut:				
Ansonia	2	190	....	....
Baltic	....	29	....	....
Bridgeport	28	1,952	250	....
Bristol	8	220	31	496
Darien	1	109	....	....
Fairfield	20	250	....	....
Farmington	3	57	8	....
Hartford	108	2,316	329	6,346
Rockville	....	123	5	175
Shelton	....	120	33	323
Southington	9	149	25	390
So. Manchester	26	335	....	....
Stonington	....	144	....	....
Wallingford	3	....	....	....
Westport	11	156	....	253
Willimantic	7	289	4	184
District of Columbia:				
Washington	153	4,289	549	12,408
Florida:				
Lakeland	75	463	100	500
Georgia:				
Bainbridge	10	....	4	....
Brunswick	5	107	5	....
Cartersville	9	....	....	....
Cedartown	20	93	25	175
Newnan	5	....	6	....
Sandersville	3	58	....	12
Thomasville	12	155	37	148
Idaho:				
Boise	....	....	20	500
Burley	....	68	....	100
Preston	....	52	....	100
Twin Falls	....	128	....	300
Illinois:				
Bloomington	14	717	23	882
Freeport	3	443	10	965
Geneva	32	219	29	....
Harvey	381	552	591	771
Hillsboro	....	90	....	45
Hoopeston	....	114	....	55
Jacksonville	....	225	....	....
Johnston City	....	104	....	108
Lake Forest	30	360	....	....
Mattoon	....	....	2	63
Mt. Olive	....	60	....	60
Morrison	3	120	2	102
Oak Park	50	1,079	35	813
Olney	....	145	....	82
Princeton	....	128	....	70
Quincy	50	580	43	....
Rock Island	20	....	40	....
Springfield	33	1,044	21	1,078
Watseka	4	....	....	....
West Chicago	3	125	2	170
Indiana:				
Attica	68	72	....	....
Auburn	3	129	3	35
Cambridge City	....	54	....	20
Connersville	27	248	40	227
Decatur	6	123	12	....
Delphi	....	60	....	....
Elkhart	38	483	60	500
Fort Wayne	50	1,343	100	2,056
Goshen	6	232	14	84
Jasper	3	85	4	....
Kendallville	3	125	....	....
Knightstown	....	64	....	34
Lafayette	12	388	10	....
Lebanon	4	....	6	....
Logansport	....	260	....	....
Marion	22	551	9	510
Martinsville	1	111	3	78
Michigan City	17	492	17	492
Mishawaka	30	357	87	542
Muncie	16	564	....	....
New Albany	5	275	30	....
Nappanee	....	....	....	63
Peru	....	255	....	....
Princeton	....	174	....	35
Seymour	2	180	....	90
South Bend	138	1,621	335	2,809
Veedersburg	....	30	....	12
Whiting	2	134	....	183
Iowa:				
Boone	12	423	8	363
Burlington	13	634	35	849
Cedar Rapids	36	763	67	1,681
Charles City	5	172	11	157
Cherokee	....	86	1	121
Cresco	7	72	7	90
Dubuque	30	685	49	1,675
Eagle Grove	....	65	....	50
Fort Dodge	20	402	38	551
Knoxville	1	66	....	60
Maquoketa	....	102	....	75
Marion	....	70	....	74
Marshalltown	3	310	4	....

	HYDRANTS		GATE VALVES	
	Placed in 1926	Total in Use	Placed in 1926	Total in Use
Iowa (Continued)				
Mason City	4	307	4	....
Missouri Valley	....	68	....	....
Muscatine	10	500	10	....
New Hampton	....	65	....	....
Osceola	....	65	....	10
Perry	5	109	4	....
Stanton	1	30	....	....
Vinton	....	90	....	....
Washington	2	142	3	75
Kansas:				
Cherryvale	....	94	....	....
Coffeyville	4	185	....	....
Columbus	....	85	....	16
Eureka	4	71	....	....
Fort Scott	....	232	....	311
Herington	....	46	6	42
Hiawatha	1	78	1	80
Humboldt	....	52	....	36
Hutchinson	15	604	....	300a
Independence	15	200	50	800
Junction City	2	175	6	325
Kansas City	28	1,432	99	1,795
Leavenworth	5	192	15	325
Lawrence	5	....	....	....
Mulberry	....	....	....	30
Newton	....	202	....	127
Paola	....	75	....	40
Kentucky:				
Ashland	89	503	....	....
Covington	26	890	50	....
Fulton	5	40	....	....
Georgetown	12	111	11	74
Henderson	4	240	10	....
Hopkinsville	2	154	11	220
Louisville	....	....	416	7,504
Somerset	....	....	2	66
Louisiana:				
Donaldsville	....	64	....	....
Jennings	5	55	2	22
Rayne	....	70	....	32
Ruston	7	90	25	82
Maine:				
Augusta	1	217	41	568
Bangor	8	378	....	840
Biddeford	22	453	....	198
Calais	....	133	....	178
Dexter	3	96	4	....
Houlton	....	114	....	....
Madison	....	47	....	80
Norway	....	41	2	60
Portland	43	1,654	100	2,220
Sanford	3	95	4	....
Skowhegan	87	....	....	....
Van Buren	....	55	....	50
Warren	....	12	....	4
Maryland:				
Baltimore	500	8,000	1,000	....
Chestertown	....	60	....	75
Frostburg	....	76	....	90
Hagerstown	12	264	....	....
Salisbury	56	104	....	....
Washington San. Dist.	377	1,800	599	2,147
Massachusetts:				
Adams	....	265	....	98
Andover	14	507	31	....
Athol	4	131	8	321
Belmont	26	386	127	949
Brockton	16	1,307	73	2,526
Cherry Valley	4	80	....	....
Clinton	5	320	8	....
Concord	5	275	....	....
Dalton	1	....	1	....
Danvers	47	359	150	730
Dracut	1	58	2	40
Dudley	1	....	2	....
Everett	9	583	....	....
Falmouth	32	349	....	....
Framingham	43	446	44	827
Greenfeld	13	476	29	722
Haverhill	4	559	17	1,675
Leominster	2	423	2	687
Lexington	21	307	57	389
Lowell	....	1,600	....	2,500
Medford	42	869	120	....
Malden	13	669	21	1,746
Milford	....	243	3	542
Milton	19	515	....	1,053
Millbury	2	85	....	79
Newburyport	8	263	....	....
North Adams	1	371	19	....
Northampton	30	730	61	528
North Attleboro	....	314	....	....
Peabody	5	420	9	576
Rockford	5	166	15	295
Shrewsbury	6	131	8	135
Somerville	23	1,254	93	2,233
So. Hadley Falls	2	143	3	90
Spencer	4	108	13	....
Swampscott	14	259	14	549
Springfield	97	2,391	275	7,842
Taunton	10	1,151	18	863
Uxbridge	8	166	....	....
Wareham	3	76	3	32
Wakefield	2	303	6	705
Whitinsville	....	234	....	213
Waltham	15	620	53	1,283
Warren	1	68	3	82
Westboro	....	120	....	....
Williamstown	12	100	10	100
Winthrop	9	354	29	830
Wrentham	2	80	10	....
Michigan:				
Albion	4	192	10	210
Ann Arbor	9	392	50	1,200
Bay City	15	1,168	26	....
Benton Harbor	7	335	....	....
Coldwater	5	163	16	245
Crystal Falls	4	....	4	....
Detroit	907	16,321	1,562	21,647
Durand	....	62	....	70
Hancock	....	175	....	150
Hastings	1	84	....	197
Highland Park	....	700	....	....
Holland	16	381	....	....
Houghton	2	98	1	186
Ironwood	2	340	15	395
Jackson	23	1,094	....	....
Kalamazoo	14	980	53	2,534
Ludington	12	300	....	150
Marquette	....	246	....	510
Mt. Clemens	5	302	14	250
Niles	6	260	10	331
Otsego	....	....	73	....
Paw Paw	....	41	....	....
Petoskey	....	96	....	284
Rochester	....	94	1	190
St. Clair	....	62	....	....
St. Louis	2	73	5	....
Sturgis	12	171	22	....
Traverse City	4	298	6	230
Yale	1	55	....	14
Minnesota:				
Anoka	....	79	....	47
Aurora	3	32	6	....
Bemidji	....	111	....	76
Cloquet	....	134	1	144
Detroit Lakes	....	71	....	....
Duluth	11	1,257	45	....
Hibbing	5	218	....	628
Little Falls	2	86	....	35
Lake City	....	155	....	154
Luverne	....	....	4	65
Melrose	2	35	....	....
Minneapolis	83	6,722	244	8,661
New Ulm	....	157	....	....
Red Wing	5	....	22	....
Rochester	8	325	21	197
St. Peter	4	50	7	37
Stillwater	15	238	7	152
Willmar	3	88	3	84
Mississippi:				
Brookhaven	2	145	3	....
Canton	1	112	2	88
Jackson	32	640	20	840
Laurel	19	....	....	....
Vicksburg	6	350	12	278
Winona	90	105	....	....
Missouri:				
Chillicothe	2	195	....	80
Clinton	4	88	20	100
Columbia	22	253	23	250
Excelsior Spgs.	1	79	....	....
Fulton	2	100	6	....
Jefferson City	3	205	3	156
Liberty	2	96	....	....
Marshall	6	181	82	82
Trenton	....	163	....	144
West Plains	4	....	6	....
Montana:				
Billings	5	259	18	454
Great Falls	9	487	18	542
Havre	....	113	....	136
Kalispell	43	331	60	496
Missoula	1	185	1	600
Nebraska:				
Columbus	....	....	2	111
Fremont	4	209	6	108
Grand Island	3	205	6	....
Hastings	12	285	15	260
Lincoln	40	1,163	79	1,938
Omaha	177	4,526	223	4,279
Seymour	....	55	....	53
New Hampshire:				
Claremont	3	172	13	420
Franklin	....	124	....	162
Keene	7	370	9	585
Lebanon	3	95	175	....
Manchester	22	1,084	38	1,715

	HYDRANTS Placed in 1926	HYDRANTS Total in Use	GATE VALVES Placed in 1926	GATE VALVES Total in Use
New Hampshire (Continued)				
Newport	1	103	1	143
Somersworth	....	109	....	213
Walpole	....	21	....	23
New Jersey:				
Belleville	33	....	61	....
Dover	13	214	102	780
Glassboro	....	130	....	....
Helmetta	....	30	....	20
Hightstown	6	60	10	100
Irvington	47	488	49	866
Jamesburg	....	42	....	44
Montclair	10	711	60	1,532
Nutley	27	365	....	....
Rahway	41	250	30	....
Red Bank	10	209	21	361
Rockaway	4	84	4	....
Verona	12	186	....	....
Washington	....	53	....	....
Woodstown	4	80	....	....
New Mexico:				
Deming	1	41	13	49
Tucumcari	....	70	1	64
New York:				
Albany	64	1,769	221	2,436
Auburn	....	704	7	765
Avon	8	60	10	150
Beacon	4	236	11	152
Binghamton	16	1,127	44	2,274
Carthage	3	116	4	....
Catskill	1	150	6	221
Cortland	6	300	6	....
Dansville	1	126	....	170
Elmira	9	662	48	1,312
Fort Plain	....	83	....	52
Frankfort	....	110	....	....
Gloversville	7	410	18	647
Geneva	....	324	1	519
Hoosick Falls	....	97	....	150
Kingston	30	500a	....	....
Le Roy	....	121	10	104
Lowville	2	116	....	304
Malone	3	125	3	....
Newburgh	31	569	52	....
Olean	20	560	50	1,500
Oneonta	5	163	....	480
Ossining	6	207	7	195
Oswego	7	541	9	406
Peekskill	20	....	30	....
Penn Yan	....	128	11	114
Perry	8	....	12	....
Saugerties	6	16	115	....
St. Johnsville	....	64	....	....
Scarsdale	36	470	153	999
Sidney	1	62	3	109
Utica	32	168	97	3,007
Waterford	2	118	5	190
Wellsville	....	123	4	110
North Carolina:				
Albemarle	4	95	2	86
Gastonia	13	343	26	394
Greensboro	52	989	60	972
Henderson	....	120	....	60
Kings Mountain	....	150	....	184
Kinston	2	141	2	87
Mooresville	....	80	....	....
Newton	....	130	....	....
Raleigh	58	554	114	902
Rocky Mount	6	257	8	281
Statesville	....	172	....	200
Troy	....	47	....	65
Wilmington	7	356	12	395
North Dakota:				
Fargo	36	587	112	....
Grand Forks	....	338	....	....
Ohio:				
Akron	248	3,680	555	9,445
Barberton	16	291	38	328
Barnesville	....	125	....	90
Bedford	25	485	....	....
Bowling Green	4	168	11	233
Bucyrus	....	219	4	300
Chillicothe	....	207	....	....
Cincinnati	242	....	568	....
Conneaut	....	259	....	289
Columbus	b	b	125	4,589
Defiance	1	210	6	80
Dennison	2	174	10	126
E. Liverpool	6	....	24	300
E. Cleveland	23	....	35	....
Eaton	....	94	....	82
Elyria	....	400	....	....
Gibsonburg	....	64	....	30
Gallipolis	6c	98	....	....
Huron	8	92	12	....
Kent	7	168	....	224
Lakewood	14	1,350	24	2,255
Lancaster	21	263	26	274
Lima	6	750	31	....
Martin's Ferry	25	350	40	....
Medina	2	100	....	....
Middletown	....	460	....	650
Montpelier	....	86	....	....
Mt. Gilead	....	56	....	30
Orrville	2	103	3	106
Saline	15	....	20	....
Sidney	199	....	270	....
Struthers	6	135	16	....
Tiffin	2	234	15	379
Urbana	3	....	22	....
Warren	23	516	44	795
Willard	....	105	....	....
Youngstown	90	....	240	....
Oklahoma:				
Blackwell	12	108	20	150
Collinsville	....	47	....	....
Guthrie	....	130	....	175
Hominy	....	59	....	82
Kingfisher	....	....	4	....
Mangum	....	83	....	50
Pawhusha	....	94	....	60
Stillwater	4	70	6	....
Oregon:				
Corvallis	3	142	20	350
Eugene	....	....	50	....
Pendleton	2	130	10	86
The Dalles	....	150	....	....
Pennsylvania:				
Allentown	16	882	63	....
Ashland	....	89	....	86
Bradford	6	420	11	852
Catasauqua	....	71	....	59
Clearfield	1	101	4	279
Coatesville	4	178	....	....
Connellsville	3	188	15	500
Corry	....	99	12	389
Duquesne	2	192	6	290
Frackville	3	43	....	120
Freeport	....	30	....	....
Huntingdon	4	56	20	....
Jersey Shore	2	95	....	....
Kittanning	....	73	6	....
Lancaster	6	850	28	1,316
Lebanon	....	319	....	918
Lehighton	4	80	14	120
McDonald	....	48	....	92
Midland	....	48	....	97
Millville	....	20	....	....
Mt. Carmel	6	96	18	....
Myersdale	....	40	....	50
Northampton	3	174	....	....
Phoenixville	8	230	25	800
Pottsville	....	302	....	633
Reading	28	1,234	78	3,948
Reynoldsville	4	63	6	37
Sayre	5	132	....	....
Schuylkill Haven	5	61	6	30
Shamokin	....	192	....	....
Sharpsville	5	115	12	....
Summit Hill	....	29	....	....
Susquehanna	....	....	2	....
Titusville	6	....	6	....
Uniontown	3	170	....	....
Woodlawn	9	167	....	....
Wilkinsburg	45	1,046	135	3,438
York	....	428	....	1,568
Rhode Island:				
E. Providence	....	189	50	459
So. Kingstown	1	209	....	....
Warwick	1	200a	28	....
Westerly	33	289	55	434
Woonsocket	101	955	210	1,600
South Carolina:				
Bennettsville	7	115	7	100
Columbia	26	....	8	....
Charleston	11	715	34	1,270
Cheraw	....	50	....	....
Darlington	....	108	....	46
Dillon	....	76	28	....
Easley	7	90	6	52
Gaffney	10	....	....	....
Rock Hill	....	149	....	100
Spartanburg	26	616	50	1,500
South Dakota:				
Brookings	1	110	6	82
Lead	....	90	....	125
Mitchell	4	179	6	158
Tennessee:				
Clarksville	....	160	....	112
Dyersburg	5	125	5	100
Elizabethtown	14	54	....	....
Erwin	1	....	1	....
Fayetteville	2	67	2	33
Kingsport	....	125	....	260
Maryville	....	128	....	90
Memphis	26	2,038	252	4,281
Milan	7	57	5	38
Nashville	500	2,471	290	3,714

	HYDRANTS Placed in 1926	HYDRANTS Total in Use	GATE VALVES Placed in 1926	GATE VALVES Total in Use
Texas:				
Big Spring	7	60	15	25
Childress	28	57	73	75
Dallas	133	2,368	....	....
El Paso	12	511	35	....
Ennis	8	111	10	234
Graham	2	105	6	180
Greenville	10	200	15	100
Mexia	15	197	16	86
Orange	2	95	6	150
San Antonio	32	2,420	....	....
San Benito	....	60	....	64
Seguin	....	....	6	....
Smithville	3	29	....	10
Tyler	10	229	45	411
Weatherford	4	82	6	125
Waco	12	550	25	1,885
Wichita Falls	19	347	116	520
Utah:				
Ogden City	9	465	22	767
Tooele	1	59	6	109
Vermont:				
Barton	4	46	2	37
Brattleboro	4	133	8	196
Newport	2	80	4	80
Northfield	....	84	....	112
Richford	....	....	1	....
Rutland	6	....	24	220
St. Johnsbury	6	200	....	....
Winooski	2	65	3	70
Virginia:				
Charlottesville	14	145	44	....
Danville	14	342	11	....
Marion	6	60	....	....
Martinsville	4	62	20	46
Newport News	23	362	54	1,392
Washington:				
Aberdeen	12	275	60	....
Bellingham	25	....	....	....
Centralia	5	103	7	....
Cle Elum	....	50	....	63
Dayton	....	90	....	....
Hoquiam	....	151	....	495
Pullman	3	72	3	100
Ritzville	....	90	....	....
Spokane	53d	2,520	....	....
So. Bend	....	29	....	85
Tacoma	56	1,645	170	3,037
Walla Walla	4	....	....	....
Winlock	....	23	....	53
Yakima	10	182	47	348
West Virginia:				
Beckley	4	58	....	....
Keyser	3	71	2	500
Morgantown	9	166	52	159
Sisterville	....	78	....	200
Wellsburg	....	68	....	....

	HYDRANTS Placed in 1926	HYDRANTS Total in Use	GATE VALVES Placed in 1926	GATE VALVES Total in Use
Wisconsin:				
Algoma	3	52	12	98
Appleton	27	532	38	794
Ashland	....	268	....	262
Baraboo	4	178	4	69
Chippewa Falls	1	....	3	....
Cudahy	....	....	9	126
Fond du Lac	32	370	55	449
Fort Atkinson	....	145	....	200
Green Bay	6	470	22	471
Janesville	5	473	9	609
Jefferson	....	64	....	62
Kaukauna	....	122	....	....
La Crosse	5	664	11	822
Ladysmith	....	73	2	112
Lancaster	....	100	....	....
Lake Geneva	8	120	....	....
Madison	92	956	72	1,707
Manitowoc	....	340	....	....
Menasha	6	156	....	....
Marinette	....	290	3	214
Milwaukee	334	4,931	886	7,434
Neenah	8	....	9	....
Oconomowoc	5	119	6	80
Port Washington	....	86	1	75
Reedsburg	1	66	....	....
Richland Center	....	90	....	....
Shawano	10	90	4	....
Sturgeon Bay	8	88	....	....
South Milwaukee	....	270	....	320
Two Rivers	....	131	....	170
Watertown	12	255	....	....
Waupaca	....	82	....	79
Wauwatosa	76	569	105	600
Wausau	4	369	40	579
Wisconsin Rapids	6	199	9	264
Canada:				
Belleville, Ont.	2	278	6	240
Charlottetown, P.E.I.	5	100	4	268
Grandy, Que.	4	87	6	10
Guelph, Ont.	1	215	18	406
Halifax, N. S.	....	657	....	1,607
Hamilton, Ont.	17	2,262	18	1,915
Hawkesbury, Ont.	....	79	....	65
Joliette, Que.	2	137	5	510
Kitchener, Ont.	8	379	34	....
N. Westminster, B. C.	....	190	....	....
Niagara Falls, Ont.	12	297	....	....
Orillia, Ont.	....	143	1	281
St. Boniface, Man.	3	245	14	800
St. Catherine's, Ont.	4	473	14	820
St. Thomas, Ont.	10	220	....	500a
Sidney Mines, N. S.	....	96	....	176
Truro, N. S.	....	150	....	....
Toronto, Ont.	93	7,657	162	8,143
Victoria, B. C.	....	907	....	1,642
Walkerville, Ont.	....	495	....	954
Winnipeg, Man.	31	2,597	61	2,870

a—approximate; b—by fire department; c—replaced; d—1925 and 1926.

Relation of Type of Pavement to Street Cleaning*

Not so Important a Factor as Cost and Several Other Conditions, Including Time and Method of Cleaning, Quantity and Quality of Refuse.

There can be no question that the type of pavement has a definite relation to street cleaning in the matter of expense involved. Other conditions being the same, it is apparent that the smoother the type of pavement the less costly should be the cleaning. It is also true, however, that costs of cleaning the same type of pavement will vary with degrees of the roughness of the pavement.

There are, however, other factors besides the type of pavement which contribute their share to the cost of street cleaning, and a fair, comprehensive study of street cleaning costs with reference to type of pavement cannot exclude the consideration of these factors. Some of these are: 1. The time at which cleaning is done, whether by day or by night. 2. The quantity and quality of street refuse. 3. The method of cleaning necessary to follow, as influenced by parking or other conditions. 4. The standard of cleanliness required or the frequency of cleaning.

In some smooth pavements in quiet suburban districts, the cleaning of litter from falling leaves may be more expensive than the cleaning of some commercial streets with pavements not so smooth and carrying three or four times the traffic. In the residential section of New Orleans perhaps the most potent factor contributing to street cleaning cost is the extent of pavement that is present or lacking on the intersecting streets. One of the main streets

*Abstract of a paper before the International Association of Street Sanitation Officials, by John Klorer, commissioner of public property of New Orleans.

of New Orleans is cleaned for a distance of 8,100 feet of double roadway, four times a week by two patrolmen using hand brooms, and a clean appearance is maintained because nearly every intersecting street is paved. A little further out, where unpaved streets intersect it each of which yields a supply of clay to wheels of passing vehicles, seven men are required to keep the same length of the same kind of pavement in the same condition as that accomplished by the two men referred to.

Granite block is the customary type of pavement in the heavy commercial, wholesale or industrial district, and the cost of cleaning here is frequently very heavy. This, however, may be due largely to the quantity of refuse on these streets and the fact that they are apt to be uneven because of the heavy tonnage which travels over them and the fact that repairs have to be made in a hurried and expeditious way.

On old granite pavements, both because of the former method of construction and because in the early years steel tired and horse drawn carriages tended to cobble the blocks, cleaning is difficult and expensive. Where a high standard of cleanliness is required on such a street it is advisable to place an asphaltic type of wearing surface. The expense involved in this surfacing may often be justified by the saving accomplished within a few years in the cost of cleaning alone.

Concrete pavements have certain features that commend them from a street cleaning point of view. They are fairly smooth when constructed and become more so under traffic. When sub-grade conditions are satisfactory they maintain a surface intact. The color of concrete does not accentuate the presence of fine dirt or dust and therefore it can remain unwashed for a longer period than asphalt without presenting an objectionable appearance. Asphalt surfaces, being smooth are easy to clean, but their dark color and absence of joints tend to attract attention to what on other types of pavement would be a negligible quantity of dirt and dust.

Concluding Mr. Klorer said, "I particularly wish to emphasize the point that the type of pavement is not so important a factor in the cost of street cleaning as other factors to which reference was made."

Discussing the same subject, E. A. Kingsley, city engineer of Dallas, Texas, stated that night parking added considerably to the difficulty of thoroughly cleaning the streets. In the business district the streets are occupied by parked automobiles practically all of the 24 hours except between midnight and six o'clock in the morning. In the residential district, day time or early evening seems to be the preferred time for cleaning, one reason being that the noise made by cleaners during the later hours of the night is objectionable. Consequently Dallas has selected the day time for cleaning the residential district and night time for the downtown district. The early hours of the night are spent in cleaning streets of the wholesale or warehouse district and the adjacent streets and the time after midnight, when the theatre crowds have dispersed, is taken for cleaning the main business streets where the parking has been heaviest.

Mr. Kingsley found sweepers, not as satisfactory as flushing on brick streets because of the small amount of dust left in the joints of the brick pavements. He did not, however, find any material difference in cost between sweeping brick, concrete or asphalt. In sweeping the streets, they combine a pick-up and a non-pickup sweeper. The non-pickup sweeper is run in the center of the street, forcing the litter towards the side, where it is picked up by the pickup sweeper. The pickup sweeper broom overlaps the edge of the path of the non-pickup sweeper and takes care of the rubbish from half the street. As the middle and quarter sections of the street are usually not very dirty, the total amount of dirt worked over by the non-pickup does not furnish any more material for the left half of the trash box of the pickup sweeper than it obtains normally from the gutter of the roadway. Consequently this method does not materially decrease the periods between dumpings of the trash boxes.

Concrete Bridge to Be Tested to Destruction

An unusual opportunity to test to destruction a large concrete bridge of modern design has been presented in North Carolina. A dam is now under construction on the Yadkin river which will cause the impounded water to entirely submerge the bridge across the river between Albemarle and Mount Gilead.

This bridge was built by the state in 1922 as a Federal-aid project and consists of three open-spandrel arch spans of about 150 feet each and 14 T-beam or deck-girder spans of approximately 40 feet each. The over-all length from face to face of the ends bents is 1,069 feet.

A cooperative agreement has been entered into between the North Carolina State Highway Commission and the Bureau of Public Roads for the making of as complete tests as possible before the bridge is submerged. It is believed that the results may be of great value to the engineering profession and in order to secure the best technical direction possible several organizations have been invited to appoint a representative on an advisory committee to take charge of the direction of the tests. An invitataion has been extended to the University of North Carolina, North Carolina State College, American Association of State Highway Officials, American Society of Civil Eningeers, American Railway Engineering Association, American Concrete Institute, Highway Research Board, Bureau of Standards, and American Society for Testing Materials.

All but two of these organizations have accepted the invitation. It is proposed that the advisory committee will formulate the test program and assume direction of the work from the technical standpoint. The program will be financed and carried out by the North Carolina Highway Commission and the Bureau of Public Roads.

The period during which the loading tests may be carried on will be limited to the interval between the time when it will be possible to close the bridge to traffic and the time when the bridge will be submerged by the water impounded by the dam. With this time limitation in view it will be necessary to make very complete preliminary arrangements for the work.

More Efficient Road Inspection*

WHAT IT IS AND HOW TO GET IT

By George Gault†

The efficiency of any process depends upon the quality of the materials used, the fitness of the mechanical equipment used, and the skill of the workmen employed in the handling of the materials and equipment. No one will question the statement that the finest material can be applied to the work in such a manner that the finished product will be practically worthless, or that the finest workmanship can not produce the best finished product with poor materials or equipment.

We all have ideals to which we hope to attain some day, and we are going to try to give you our idea of an ideal road inspection system. We realize that it will not be possible for us to use this system under existing conditions, but we feel that if we have some definite goal ahead we are more apt to make some progress in that direction. As conditions change we may have to change our goal to meet them, but if the angle of deflection is not too large, we have not wasted any of our efforts in the progress we have made up to that time.

As the efficiency of road inspection depends largely upon the efficiency of the inspector, let us first consider some of the characteristics of the ideal inspector.

FIRST. He should be a man of such temperament that he can make any necessary suggestions or criticisms in such a way that those actively engaged in performing the work will feel that he is making the suggestions or criticisms entirely for the benefit of the work, and not to show his authority. He should be able to judge the temperament of those with whom he has to deal, and act accordingly. By this we mean, that it will only be necessary to make a suggestion to one contractor, while with another it will be necessary to follow up and see that the suggestion is followed out.

We believe that this question of personality should be given serious consideration, as harmony is the strength and support of all institutions, and any lack of it between the inspector and the contractor, or between the inspector and the engineer, can only result in detriment to the work.

SECOND. He should be a man who has a working knowledge of all materials to be used in the work, and be able to decide as to their fitness for the particular kind of work to be done. If any of the materials are to be obtained locally, such as gravel or stone, he should make frequent inspections of the pit or quarry to see that material of inferior quality is not allowed to mix with material of proper quality in such proportions that it can not be detected when considered as a whole. Where the source of supply for the material is too far from the work to permit of this kind of inspection, he should inspect as much of the material as may be possible at the unloading point. He should see that all materials are properly stored from the time of unloading to the time that they are actually applied to the work, and at that time should see that all materials are in a satisfactory condition to comply fully with the specifications.

THIRD. If the process of construction requires the mixture of materials, he should see that the materials are mixed in the proportions specified, and that the equipment used is such that the materials are properly mixed. He should give careful attention to the application of either raw or mixed materials to see that it conforms in every way to the specifications, as well as the stakes set by the engineer. The inspector should be furnished with a set of blue prints together with the specifications and should assist the engineer in setting the final stakes for the improvement, so that he will be thoroughly familiar with the plans and specifications as well as the actual points from which the work is being laid out. As we feel that the grading and drainage is of prime importance, the inspector should give particular attention to this part of the work.

So far we have been dealing with the requirements and duties of the inspector. We feel that the efficiency of our road inspection might be increased by a change in the method of handling some of the questions which are sure to arise as the work progresses. The inspector should be made to feel that he has a real job and that the quality of the work depends largely on him. We think that the inspector sometimes feels that he is appointed merely to comply with the law, and that anything that he may say or do will have little effect on the completed work. This feeling is aggravated by having the contractor appeal directly to the engineer for a decision on any question which may arise between the contractor and the inspector. We feel that this might well be corrected by the engineer announcing all his decisions through the inspector, and thus make him feel the responsibility of his work. We know that you are wondering where such an inspector can be found, but please remember that this is an ideal, and is to be approached as nearly as possible. We know that you are also thinking of the cost of securing such an inspector, and are ready to quote our present law on this subject. We freely admit that this can not be done under our present law, but if our present law does not provide for the best method, we should use such means as are in our power to secure the necessary legislation to provide for the more efficient method.

After the work has been inspected as outlined above we think that some mechanical device might be used to test the road surface. We would suggest that this be done by a device that would not only record the rough spots, but would also leave a mark, (such as a spot of whitewash), at each rough spot.

To meet the requirements we have outlined, it

* Paper delivered at Thirteenth Annual Road School, Purdue University.

† County Surveyor, Wayne County, Indiana.

would be necessary that the inspector have some engineering or contracting experience, and the rate of pay should be such that it will attract such a man. It must be remembered that this work will be of a more or less temporary nature and that the rate of pay will have to be relatively larger than for similar work of a permanent nature.

The additional cost of construction which would result from the use of this method of inspection would be saved, at least in part, in the cost of maintenance. Any saving of this kind would tend to reduce the general taxes which is an item worthy of our consideration at any and all times. It is not possible to show just what saving might be effected in this way, but we feel sure that a considerable part of the cost of maintenance might be avoided if a more careful inspection was made at the time of construction. Assuming that the average cost of construction of our roads of all types is $25,000 per mile, and that two months is about the average time required to complete a mile of road, the cost of inspection under our present system would be about $180 per mile, or about 0.7 per cent of the total cost.

Using the same assumption as to cost of construction and time required to complete, and the further assumption that an inspector such as we have outlined could be secured for a salary of $200 per month, the cost of inspection under the system we have outlined would be $400 per mile, or about 1.6 per cent of the total cost of the work.

Some years ago, while in the employ of one of the larger railroad systems of the country, the writer was assigned to the work of inspecting piling which was being driven for use as temporary supports for the old bridge while a new one was being built. We were required to keep a record of the kind of timber in each pile, the diameter at each end, the exact length, and the penetration resulting from the last three blows of the hammer from a given height of drop. A sketch was placed in the office files giving this information for each pile, in spite of the fact that within a year all of these piles were removed.

At a later date the writer was assigned to the inspection of certain steel appliances for the same railroad system. This work included the inspection of the material as received at the factory, and the method of manufacture, as well as the finished product.

Later, when employed in a small industrial factory where the product contained two malleable castings which were purchased from a foundry not controlled by the factory, we found that it was required that each casting have two test lugs which were cut off by an inspector to determine the quality of the material.

In passing through one of the largest auto factories at Detroit it was noticed that about one man in every ten or twelve wore a coat of distinctive style and material. Upon inquiry we were informed that these men were inspectors, and that it was considered necessary to have an inspector for each operation required for the construction of a car.

While it is not possible for us to quote the exact cost of these inspections or the relative cost as compared to the total cost of the items mentioned, we feel sure that the percentage is much greater than that of the country road inspection which we are proposing. If, in view of the keen competition in the industrial world and the necessity of meeting the dividend payments in the corporation world, it is felt that a rigid system of inspection is necessary, we should not hesitate to spend an equal or greater part of our public money for an adequate road inspection.

There are always those who will say that a too rigid inspection reflects upon the integrity of the contractor, but we feel that the honest and conscientious contractor will welcome any fair system of inspection and the loss of the unscrupulous contractor would not seriously interfere with the construction of good roads.

As a summary of the entire discussion we would suggest the following:

(1) Amend our road law so that we can pay the salary necessary to secure an efficient inspector.

(2) Appoint an efficient and conscientious inspector.

(3) Handle the work in such a way that he will feel the importance of his work.

We would like to say in closing that we think the inspection should continue after the road has been completed. We believe that the engineer should make inspections of the road from time to time so that any defects might be noted and such changes be made in the specifications or system of inspection as may be necessary to correct any defects which may be apparent.

Sewage Treatment at Columbus, O.

The sewage treatment plant of Columbus, O., was in operation only 129 days during 1926—a less number than in any previous year. The plant was not operated at all during January to March and October to December inclusive, and only one and one-half days in April and 5 days in September.

The sprinkling filters began operation in April at the rate of 1.97 m.g.d. and increased this to a maximum of 3.43 in September. The mean rate for the season was 3.02 m.g.d., which is fifty percent higher than the dosage for which the filters were designed and 0.25 higher than was ever before applied. The mean dosing period was 59.5 minutes and the mean resting period 14.6 minutes. During August, when the mean rate was 3.26 m.g.d. (mean rate of dose 3.51 m.g.d.) the mean dosing period was 137.2 minutes and the mean resting period 10.6 minutes.

Paving With Gold

In constructing a Colorado state highway between Denver and Colorado Springs, the contractor on a five mile section used for his coarse aggregate rock from the ore dumps of the Cripple Creek gold field. It is stated that this material assayed at $1.50 per ton and as about 2,000 tons of stone were used in each mile, there would be about $3,000 in gold, or $15,000 in the five mile stretch.

Recent Legal Decisions

VILLAGE PROPERTY CANNOT BE GIVEN FOR PRIVATE PURPOSE

A municipality cannot, by statute, be authorized to raise funds in aid of a manufacturing enterprise and bonds issued by it for such a purpose are void, because the promotion of private manufacturing enterprises is not a public purpose. Village officers, the Wisconsin Supreme Court holds, Village of Suring v. Suring State Bank, 207 N. W. 944, have no power to give away the property of the village for a private purpose and their deed thereof is void.

STATUTE AND BOND COVERING CLAIMS OF MATERIAL-MEN FURNISHING MATERIAL TO SUBCONTRACTOR ON PUBLIC WORKS

In determining the surety's liability to third persons on a bond given for their benefit and to secure the faithful performance of a building contract as it relates to them, the contract and bond are to be read together.

The North Carolina statute, Comp. St. § 2445, is similar to the federal statute on the subject, and provides that "any laborer doing work on said building and materialman furnishing material therefor and used therein" shall have "the right to sue on said bond, the principal and sureties." The federal statute and bond thereunder have been held sufficient to cover claims of materialmen furnishing material and supplies to a subcontractor. The surety cannot complain of this holding, because he knows that the statute enters into and becomes a part of the undertaking. The acceptance by the materialman of a 90-day trade acceptance due from the contractor, as a matter of business convenience, is not a bar to his right to recover on the bond.

Where the general contractor agrees to provide "all the material and perform all the work" required for the erection of the building, and to "pay for all labor done on, and all material and supplies furnished for said work" these provisions, read in the light of the statute, look to the protection of those who furnish the labor and materials provided for in the contract, and not to the particular contract or engagement under which they are supplied. If the general contractor sees fit to let a portion of the work to a subcontractor, who employs labor and buys materials which are used to carry out and fulfil the engagement of the original contractor, the principal contractor is thereby furnished with the labor and materials for the fulfilment of his engagement as effectually as he would have been had he directly hired the labor or bought the materials. Standard Electric Time Co. v. Fidelity & Deposit Co. of Maryland, (N. Car.) 132 S. E. 808.

To the same effect was Independent Trust Co. v. Porter & Boyd (N. Car.) 132 S. E. 806, decided at the same time.

The above would not apply to a public works contract bond taken before the statute was amended. February 17, 1923, where the contract did not require the contractor to pay for labor and material, and the bond was not conditioned for payment therefor, but to indemnify the obligee, such as a board of trustees or a board of education, Page Trust Co. v. Carolina Const. Co. (N. Car.) 132 S. E. 804; Ideal Brick Co. v. Gentry (N. Car.) 132 S. E. 800.

LIABILITY OF MUNICIPALITIES SUPPLYING PUBLIC UTILITIES

Municipalities supplying public utilities are to be considered just as are other public service corporations similarly engaged, in relation to the Public Service Commission Law. Littleton v. Hagerstown, Maryland Court of Appeals, 132 Atl. 773.

QUALITY OF PAVEMENT, MANNER OF DOING WORK AND TIME THEREFOR WITHIN DISCRETION OF MUNICIPALITY

The Pennsylvania Supreme Court holds, City of Philadelphia v. Pennsylvania Salt Mfg. Co., 286 Pa. 1, 132 Atl. 792, that the fact that the city paid for the paving of the street in front of other property abutting on the improvement does not amount to an unlawful discrimination. The right to assess by the front foot rule is a statutory one and is not dependent upon absolute uniformity throughout the city where conditions may require a different plan of pavement.

A change in the character of the paving in front of an abutting owner's property, thereby greatly increasing the cost, is usually a matter within the discretion of the municipality. It is the city's right to determine the quality of pavement, the manner of doing the work, the terms of the contract, etc., without consulting abutting owners. Conditions of traffic and the uses to which a street will probably be put must, in all cases, determine the nature of the paving, and it may be more economical in the long run to expend a greater amount of money for the original paving, in this way eliminating the need for early repairs.

The fact that on account of delay in the paving of the street there was a considerable increase in the cost by reason of the advance in price of labor, materials, etc., is not a defense to an action for the cost of paving improvements, the time of doing the work being solely within the discretion of the municipal authorites.

OBLIGATION ON MUNICIPALITY RETAINING CONTROL OF STREET UNDER CONSTRUCTION

The Pennsylvania Supreme Court holds, Reichard v. Bangor Borough, 286 Pa. 25, 132 Atl. 803, that where, instead of turning a street over exclusively to a sewer contractor with the right to close it to public traffic during the period the construction work is progressing, the agreement with the municipality expressly stipulates that the contractor shall maintain sidewalks and roadways in "satisfactory condition," which necessarily means to the proper borough authorities so as to cause a minimum of inconvenience to the traveling public, an obligation is imposed on the municipality to see that the highway is maintained in a reasonably safe condition for both pedestrian and vehicular traffic.

NECESSITY FOR ACCEPTANCE OF STREETS, ETC., LAID OFF ON PLANT BY OWNER

The North Carolina Supreme Court holds, Irwin v. McAden, 136 S. E. 368, that where an owner lays his land off into lots and streets with a view to making sales in reference to them, and causes a plat or map of the lots, streets, alleys, and parks to be registered, and executes deeds referring to the map as a part of the description, he thereby dedicates the streets, alleys and parks to the use of those who purchase the lots, and under some circumstances also for the use of the public. The reason of the rule is the grantor induces purchasers to believe that the streets, alleys and parks will be kept open for their benefit; but the principle is equitable in its nature and is founded upon the idea that it would be at least unjust for the landowner to question or limit the right of his grantees to the privileges and easements expressly given or implied from his conduct. So far as the general public is concerned, the North Carolina courts hold, in accordance with the general rule, that a dedication is never complete until acceptance; neither burdens nor benefits with attendant duties may be imposed upon the public unless in some way it has consented to assume them; and until acceptance is established it should be termed a revocable offer of dedication.

COMPENSATION FOR AUDIT OF TOWN'S BOOKS

The North Carolina Supreme Court holds, Mason v. Town of Andrews, 133 S. E. 402, that a contract for a complete audit of a town's books, no time for completion being specified, must be performed within a reasonable time. If there were mistakes and inaccuracies in the audit, the auditor would be entitled, under the contract, to the amount per diem as agreed upon for a reasonable time in making the audit less so much as it would take to reform the audit and make a complete audit in accordance with the contract.

MUNICIPALITY HELD NOT LIABLE FOR ACCIDENT IN PARK SWIMMING POOL

The Georgia Court of Appeals holds, Jones v. City of Atlanta, 133 S. E. 521, that a city was not liable for injuries to a bather sustained by striking an obstruction when diving from a raft in a swimming pool in a park maintained by the city, although there was a nominal charge of 10 cents for the use of the pool, that not being sufficient to show that the city was maintaining the park for the purpose of raising revenue.

RELATIONSHIP OF MASTER AND SERVANT DOES NOT EXIST BETWEEN CONTRACTOR AND A SUBCONTRACTOR WHO IS AN "INDEPENDENT CONTRACTOR"

The North Carolina Supreme Court holds, Greer v. Callahan Const. Co., 130 S. E. 739, that the relationship of master and servant does not exist between a contractor and subcontractor when the latter is an "independent contractor," that is, one who exercises an independent employment, contracts to do a piece of work according to his own judgment and methods, and without being subject to his employer except as to the results of the work, and who has the right to employ and direct the action of the workmen independently of such employer and freed from any superior authority in him to say how the specified work shall be done or what the laborers shall do as it progresses.

ASSOCIATION BY-LAW REQUIRING DUES BASED ON PERCENTAGE OF PUBLIC WORKS CONTRACTS HELD INVALID

The Kentucky Court of Appeals holds, Kentucky Association of Highway Contractors v. Williams, 280 S. W. 937, that a by-law of a contractor's association requiring members to pay dues based on a percentage of contracts secured by the member for federal, state and county highway work was void as against public policy, creating a stimulus to increase bids on a public contract to recoup the bidder.

ADJACENT OWNERS SEEKING INJUNCTION AGAINST PUBLIC PLAYGROUND MUST SHOW SPECIAL DAMAGE

In a suit to enjoin a municipality from closing certain streets and converting portions thereof, together with certain adjacent lots, owned by the municipality, into a public park, playground and athletic field, the Virginia Supreme Court of Appeals holds, City of Lynchburg v. Peters, 133 S. E. 674, that a mere allegation that the complainants, adjacent lot owners, would suffer irreparable injury therefrom without showing any special or peculiar damage as distinguished from that sustained by the public at large, was not sufficient.

MATERIALS AND LABOR COVERED BY HIGHWAY CONTRACTORS' BONDS

The Virginia Supreme Court of Appeals holds, Fidelity Deposit Co. of Maryland v. Bailey-Spencer Hardware Co., 133 S. E. 799, that a highway contractor's bond, guaranteeing payment for "all materials, equipment, teams and labor" furnished in the construction included explosives and hardware necessarily and usually incident to road construction work, such as mule shoes and nails, machine bolts, washers, wrenches, halters, harness, leather, grease, soap, shovels, pick handles, etc.

The North Carolina Supreme Court, Chappell v. National Surety Co., 133 S. E. 21, holds that such a bond covers feed consumed by the contractor's teams.

It also covers the board of men actually engaged in the construction work. Fidelity & Deposit Co. v. Bailey (Va.), 133 S. E. 797, and the services of a superintendent of the work. Fidelity & Deposit Co. v. Mason (Va.), 133 S. E. 793.

LIABILITY OF PRINCIPAL CONTRACTOR TO SUBCONTRACTOR'S EMPLOYEE

The North Carolina Supreme Court holds, Greer v. Callahan Construction Co., 190 N. C. 632, that the contractor for the construction of a public highway for the highway commissioners of a county, having undertaken the work with the knowledge that blasting by dynamite was necessary in its performance, is not relieved from liability to a laborer who is injured while engaged in the work with the dangerous instrumentality contemplated and necessary, because the laborer was an employee of an independent contractor who, under contract with the principal contractor, undertook the construction of a portion of the highway in accordance with the original contract.

NEWS OF THE SOCIETIES

June 4-6—CONFERENCE OF STATE SANITARY ENGINEERS. Annual meeting at Chicago, Ill.

June 6-8—AMERICAN ASSOCIATION OF ENGINEERS. Annual convention at Tulsa, Okla.

June 6-10 — NATIONAL ELECTRIC LIGHT ASSOCIATION. Annual convention and exhibition at Atlantic City, N. J.

June 6-11 — AMERICAN WATER WORKS ASSOCIATION. 47th annual convention at Chicago, Ill.

June 6-11—U. S. GOOD ROADS ASSOCIATION. Annual meeting at Savannah, Ga.

June 13—CANADIAN PUBLIC HEALTH ASSOCIATION. Annual meeting at Toronto, Can.

June 20-24—AMERICAN SOCIETY FOR TESTING MATERIALS. Annual meeting at French Lick, Ind.

June 27-30—SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION. Annual meeting at Oreno, Me.

Aug. 16-19—INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Annual convention at Salt Lake City, Utah.

September—CITY MANAGERS ASSOCIATION. Fourteenth annual convention, Dubuque, Ia.

October 3—AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS: Annual meeting at Denver, Colo.

Oct. 17-21—AMERICAN PUBLIC HEALTH ASSOCIATION. Annual convention at Columbus, O.

Nov. 7-9—NORTH CAROLINA SECTION, AMERICAN WATER WORKS ASSOCIATION. Annual meeting at Durham, N. C.

Nov. 14-18—AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS. Thirty-third annual convention at Dallas, Tex.

Nov. 28-Dec. 2—ASPHALT PAVING CONFERENCE. Sixth annual conference at Atlanta, Ga.

Jan. 9-14—AMERICAN ROAD BUILDERS' ASSOCIATION. Annual convention and road show at Cleveland, O.

SOUTHEASTERN WATER AND LIGHT ASSOCIATION

The annual convention of the Southeastern Water and Light Association was held at Jackson, Miss., April 26-28. E. O. Sweet of Birmingham was re-elected president and W. F. Steiglitz of Columbia, S. C., secretary. Vice-presidents were elected for each state as follows: Mississippi, E. M. Foster, of Greenville; Tennessee, A. F. Parzelius, of Chattanooga; Alabama, Robert L. Totten, of Birmingham; South Carolina, H. W. Schumpert, of Newberry; Georgia, W. W. Hunter, of Augusta; Florida, H. R. McKain, of Jacksonville; North Carolina, H. A. Lily, of Baden. Selection of next year's convention city was deferred until announcement by the American Waterworks Association of its choice, Atlanta and Palm Beach being under consideration. Should the city selected come within the territory of the Southeastern Association, a joint session will be held.

AMERICAN SOCIETY FOR TESTING MATERIALS

The thirtieth annual meeting of the A. S. T. M. will be held at French Lick, Ind., June 20-24. Officers for the coming year have been nominated as follows: President, H. F. Moore, professor of engineering materials, University of Illinois, Urbana, Ill.; vice-president, T. D. Lynch, manager, materials and process engineering department, Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.; executive committee, F. O. Clements, director of research, General Motors Corporation, Detroit, Mich.; W. H. Klein, general superintendent, Dixie Portland Cement Co., Richard City, Tenn.; F. C. Langenberg, metallurgist, Watertown Arsenal, and metallurgist, Climax Molybdenum Co., New York City, and F. N. Speller, metallurgical engineer, National Tube Co., Pittsburgh, Pa.

AMERICAN ROAD BUILDERS' ASSOCIATION

Prizes for essays by college students on "Benefit to a Nation by Improved Highways" have been awarded by the Association as follows: First prize, S. A. Lesniewski, De Pauw University; second, John R. Shepler, Harvard University; third, Reginald F. Jacobs, Massachusetts Institute of Technology; fourth, Roland Maulhauser, Cleveland, O.; fourth, Angus Tresidder, Cornell University; fifth, Charles Fitzgerald, Chicago; sixth, H. H. Rogers, Raleigh, N. C.

AMERICAN WATERWORKS ASSOCIATION, FLORIDA SECTION

The first annual meeting of this section was held at Hollywood and West Palm Beach, April 12 and 13, with about 70 present. Among the papers presented were: "Construction and Operation of the New Ft. Pierce Filter Plant," by F. P. Larmon, designing engineer, which was discussed by W. Austin Smith, city manager of Ft. Pierce; "Value of Well Records," by Herman Gunter, state geologist, discussed by H. C. Gray, Gray Artesian Well Co.; and a paper and demonstration by Charles H. Eastwood, Wallace & Tiernan Co., on "The Sterilization of Water Mains." This paper was discussed by F. W. Lane. At the afternoon session, the papers included "Water Supply Surveys," which related especially to a recent survey made at Jacksonville, Fla., by Malcolm Pirnie, of Hazen & Whipple, West Palm Beach. This paper was discussed by Alex. Taylor. Paul De Moya, superintendent of the Stuart, Fla., plant, read a paper on "Iron Removal," which was discussed by Malcolm Pirnie.

A manufacturers' banquet in the evening was well attended. The second day was devoted to a trip by bus to Ft. Lauderdale and West Palm Beach and the inspection of new plants at those places. Orlando was chosen for the meeting place in 1928.

AMERICAN WATERWORKS ASSOCIATION

The 47th annual convention of this association will be held at the Hotel Sherman, Chicago, Ill., June 6 to 11. The program of the meeting, following registration Monday morning, is as follows:

Monday.—2:30: Round table discussion in Ball Room; 2:30: Meeting of Committee on Standard Methods of Water Analysis; 4:30: Meeting of Standardization Council; 9:00: Reception and dance.

Tuesday.—9:30: Opening of convention; announcement of officers and trustees elected for 1927-28; reports of secretary, treasurer, and executive committee: action on budget; award of John M. Diven Memorial Medal; report of Standardization Council; "Quality of Water and Industrial Development," by W. D. Collins.

2:30: "Restoration of Water Service in Miami following the Hurricane," by H. H. Hyman; "The Underwriters' Laboratory and Waterworks Equipment," by Dana Pierce; "The Chicago Avenue Tunnel Construction Methods," illustrated, by John S. Dean; "Chlorination Control in Chicago," by A. E. Gorman; "The New Water Supply of Amarillo, Texas," illustrated, by Wynkoop Kiersted. Election of members of nominating committee.

8:30: Address of welcome by Mayor Thompson; address by R. W. Wolfe, Commissioner of Public Improvements of Chicago; "Program of Improvement of Water Service in Chicago," illustrated.

Wednesday.—9:00 (Ball Room): "Distribution System of Chicago Waterworks," illustrated, by J. B. Eddy; "Public Relations," by Dana Pierce; "Legal Decisions Affecting the Financing of Water Utilities," by Cecil F. Elmes; Progress Report of Committee on Private Fire Protection Services, Nicholas S. Hill, Jr., chairman; "Duplex Filter Bottoms," by F. B. Leopold.

9:30 (Louis XVI Room): Conference on Boiler Feed Water Studies; Progress Report, Sheppard T. Powell, chairman; "Priming and Foaming of Boiler Waters," by C. W. Foulk; "Boiler Feed Water Treatment from a Manufacturer's Standpoint," by J. B. Romer; "Zeolite Water Treatment in a Large Central Heating Plant," by A. H. White, J. H. Walker, E. P. Patridge.

2:00 (Ball Room): "Compensation of Executive and Technical Forces Employed in Water Works and Other Utilities," by William W. Brush; "The New Water Works Plant at Spartanburg, S. C.," by H. F. Weideman; "Application of Machines for Water Consumers' Accounting Problems," by D. C. Grobbel; "Failure of Main Viaduct Pipe Line at Utica, N. Y.," by F. E. Beck.

2:00 (Louis XVI Room): "The Value of Boiler Water Treatment to the Mechanical Department," by J. F. Raps; "Water Treatment from the Standpoint of Railroad Efficiency," by E. M. Grime; "Treatment of Locomotive Feed Water from the Chemical Standpoint," by W. M. Barr.

4:00: Boat ride on Lake Michigan.
6:45: Dinner of water purification division.
9:30: Smoker, Ball Room.

Thursday.—9:30 (Ball Room): Symposium on Well Water Recessions; "Geological Features of Northern Illinois in Relation to Underground Water Resources," illustrated, by M. M. Leighton; "Application to Iowa," by James H. Lees; "Application to Wisconsin," by Leon Smith; "Application to Indiana," by Charles Brossman; "Sanitary Safeguards in Development of Ground Water Supplies," by W. Scott Johnson; "Analysis and Tests for Capacity of Water Supplies from Sand and Gravel Formations," by W. G. Kirchoffer.

9:30 (Louis XVI Room): "Notes on Decolorization of Soft Waters," illustrated, by Robert Spurr Weston; "Sodium Aluminate Solution as an Adjunct to Alum Coagulation," by C. H. Christman; "Studies of Double Coagulation at Cincinnati," by Clarence Bahlman; "New Developments in Water Softening," by C. P. Hoover; "Pre-sedimentation and Basin Detention at St. Louis," illustrated by John D. Fleming.

2:00 (Ball Room): "The New Miami, Fla., Water Softening Plant," by L. R. Howson; "Recent Developments in Control of Electrolysis," by E. E. Minor; "Experiences With Goose-Necks or Service Connections of Lead, Wrought Iron and Copper," by Emil Nuebling; Progress Report of Committee on Steel Standpipes and Water Towers, J. E. Gibson, chairman.

2:00 (Louis XVI Room): "Some Operating Problems in Connection With Purification of Lake Michigan Waters," by Paul Hausen; "The Extension of Aeration in Water Purification," by W. S. Mahlie; "A Review of Different al Methods for the Coli-Aerogenes Group of Bacteria," illustrated, by S. A. Koser; "The Study of the Significance of the Test of Capillarity of a Sand as a Measure of its Permeability," by R. G. Tyler; "The Graphic Presentation of Analytical Data, and a Novel Method of Reporting Such Data by Means of Graphs and Charts," by A. J. Authenreith.

Friday—9:30 (Ball Room): "Modern Pumping Station Design and Its Probable Future Development," by A. L. Mullergren; "Present-Day Tendency to Use Electric Pumps as Standbys in Steam Operated Stations," by D. E. Davis; "Water Hammer, Its Cause and Control," illustrated, by L. D. Gayton; "Protection of Sub-Surface Structures Against Freezing," illustrated, by S. D. Bleich; "The Graphic Water Level Recorder—An Aid to More Efficient Operation of Reservoirs and Filter Plants," by G. C. Covert.

9:30 (Louis XVI Room): Symposium on Tastes and Odors. "Cooperative State Control of Phenol Wastes Pollution on the Ohio River Watershed," by E. S. Tisdale; "Progress in

Control of Oil Pollution," by Almon L. Fales; "Some Quantitative Studies of Phenols in Water Supplies," by Wellington Donaldson and R. W. Furman; "Recent Improvements in the Art of Pre- and Super-Chlorination," by L. H. Enslow; Progress Report of Committee on Standard Methods of Water Analysis, Jack J. Hinman, Jr., chairman.

2:00 (Ball Room): "The Story of Chlorine," illustrated, by R. T. Baldwin; "Sedimentation Studies of Turbid American River Waters," by A. W. Bull and G. M. Darby; "Recent Developments in Water Pipe," illustrated, by R. R. Silver; "Seven Years' Observation on Slow Sand and Mechanical Filtration at Toronto," by A. U. Sanderson; Progress Report of Committee on Purification Plant Loadings, H. W. Streeter, chairman.

2:00 (Louis XVI Room): Round table discussion.

Saturday—9:00 (Ball Room): Meeting to discuss the subject of a proper outlet for papers on sewage research and sewage treatment plant operation.

LIST OF FIRMS WHO HAVE MADE APPLICATION FOR EXHIBIT SPACE

National Water Main Cleaning Co.
U. S. Cast Iron Pipe and Foundry Co.
R. D. Wood & Co.
The Leadite Company
Gamon Meter Company
LaMotte Chemical Products Co.
The A. P. Smith Mfg. Co.
The Federal Meter Corp.
The Central Foundry Co.
Mueller Co.
Simplex Valve & Meter Co.
W. P. Taylor Company
East Jersey Pipe Company
A. D. Cook, Inc.
The Kennedy Valve Mfg. Co.
W. & L. E. Gurley
Sullivan Machinery Company
Wallace & Tiernan Co., Inc.
National Tube Company.
Chicago Bridge & Iron Works.
Michigan Valve & Foundry Co.
The Pitometer Company
Ross Valve Mfg. Co., Inc.
De Laval Steam Turbine Co.
R. W. Cramer & Company, Inc.
Lead Lined Iron Pipe Company
Vogt Brothers Mfg. Co.
Layne & Bowler Mfg. Company
Builders Iron Foundry Co.
National Meter Company
Rensselaer Valve Co.
Badger Meter Mfg. Co.
Traverse City Iron Works
American Well Works
The Ludlow Valve Mfg. Co.
Birch Manufacturing Co.
Barber-Greene Company
McWane Cast Iron Pipe Co.
Waterous Fire Engine Works
Eddy Valve Co.
Hays Manufacturing Co.
Hersey Manufacturing Co.
Pittsburgh Des Moines Steel Co.
Lock Joint Pipe Co.
Joseph Dixon Crucible Company
Pittsburgh Testing Laboratory
Automatic Cone Valve Co.
H. W. Clark Co.
Worthington Pump & Machinery Corp.
Edward E. Johnson, Inc.
American Cast Iron Pipe Co.
Hydraulic Development Co.
The Fred W. Hanks Company
Ohio Varnish Co.
William H. Cater
Neptune Meter Co.
Thomson Meter Corp.
Geo. H. Snell
Iowa Valve Co.
Joseph G. Pollard Co., Inc.
Edson Manufacturing Corp.
Burroughs Adding Machine Co.
United States Silica Co.
F. B. Leopold Co., Inc.
Pittsburgh Equitable Meter Co.
Penstock Construction Co.
Petroleum Iron Works Co.
International Filter Co.
Union Water Meter Co.
Buffalo Meter Co.

NEW YORK SECTION, AMERICAN WATER WORKS ASSOCIATION

The New York section of the A. W. W. A. held a meeting May 5 and 6 at Oswego, N. Y., with an attendance of nearly one hundred. Papers at the Thursday session included "Water Works Accounting," by F. C. Hopkins, of the Consolidated Water Co., Utica; "Electrifying Auburn's Pumping Station," by A. J. Adams, superintendent, and "Experiences with Severance of Polluted Auxiliary Fire Lines," by C. A. Holmquist, state board of health, read by A. F. Bedell, assistant engineer. Friday's papers included "Oswego's Lake Intake Troubles" by William McCaffrey, superintendent; "The Buffalo Filtration Plant," by Geo. C. Andrews, in charge, and "Water Services," by J. W. Ackerman, city manager of Watertown.

DETROIT ENGINEERING SOCIETY

This society on April 16th elected the following officers: President, Wm. F. Zabriskie; vice-presidents, Chas. J. Peck and J. P. Hallihan; secretary-treasurer, F. A. Kimmich.

CONFERENCE OF STATE SANITARY ENGINEERS

The eighth annual conference of State Sanitary Engineers will be held at the Hotel Sherman, Chicago, Ill., June 4-6. The Saturday morning session will be given over largely to committee reports and business. In the afternoon there will be, in addition to committee reports, discussions on the use of sodium aluminate in water purification, and on the standardization of chlorine tank valve connections. Sessions will be resumed Monday morning with committee reports on milk sanitation, pumps and sewage treatment, and round table discussions on wells. At the afternoon meeting committee reports will be presented on camp sanitation, ventilation, real estate development sanitation, and shellfish, and there will be discussions on the retardation of chlorine reaction in water and on garbage disposal.

PERSONALS

George H. Ferguson has been appointed Chief Sanitary Engineer for the Provinces of Quebec and Ontario by the Canadian Department of Health.

R. A. Thompson, Dallas, Tex., Consulting Engineer, has been appointed engineer of the Texas State Highway Commission. Mr. Thompson has had extensive engineering experience in various lines of work.

Russell S. Greenman has resigned as Senior Assistant Engineer, office of the State Engineer of New York, and has opened an office in Albany for the practice of concrete engineering, with laboratory facilities for testing and inspection.

R. Platt Boyd, a former State Highway Commissioner of Alabama, has been elected secretary of the Alabama branch, Associated General Contractors.

Henry F. Meryweather, for 20 years an engineer of the Board of Public Works of Denver, Colo., and for a time its city engineer, died April 16, aged 77 years.

William M. Acheson, formerly division engineer of the highway commission of the Dept. of Public Works of Syracuse, N. Y., has been appointed chief of the engineering division of the Dept. of Public Works of New York State.

John Ericson, city engineer of Chicago for most of the time since 1897, died April 16, aged 69 years.

Mike Roseberry, president of the Kansas Engineers' Association and former county engineer of Sedgewick Co., Kansas, has been employed as the first city manager of Newton, Kans.

William H. Connell has resigned as engineering executive of the Pennsylvania State Highway Department, a position which he held for four years.

Samuel Eckels, formerly assistant director, department of public works of Allegheny County, Pa., has been appointed to the position resigned by Mr. Connell, to which the title of deputy secretary has been given.

J. W. Turner has resigned as city engineer of Lake Wales, Fla.

J. S. Whitehurst, formerly assistant city engineer of Lake Wales, Fla., has been appointed city engineer.

Ray Dunlap, formerly division engineer of the Missouri State Highway Commission, has been appointed engineer in charge of the Bureau of Construction.

Andrew F. Eschenfelder, formerly assistant engineer bureau of construction, Essex County, New Jersey, has been appointed borough engineer of Glen Ridge, N. J.

Herbert W. Yeo, formerly county surveyor of Dona Ana County, New Mexico, has been appointed state engineer of New Mexico.

R. W. Orebaugh, formerly city engineer of Manatee, Fla., has been appointed resident engineer on road work for the State Highway Dept. of Vermont.

Francis Steeno has been appointed city engineer of Green Bay, Wis.

W. B. Hall has been appointed city engineer of Oconto, Wis.

CIVIL SERVICE EXAMINATIONS

Transitman: Applications received to June 14. To fill vacancies in Forest Service and other positions requiring similar qualifications. Entrance salary, $1,680 a year. Duties consist of making boundary surveys under supervision, assisting with computations, preparation of maps and descriptions, and related work. Competitors will not be required to report for examination, but will be rated on their education, experience and fitness.

MUNICIPAL AND OTHER PUBLIC REPORTS

Stream Pollution and Sewage Disposal. Engineering Extension Department, Iowa State College, Ames, Ia. 32 pages. Ill. Contains the following papers: Recent Progress in Sewage Disposal and Stream Pollution, by J. W. Mendelsohn; Iowa's Water Supply Problem in its Relation to Sewage Disposal, by H. V. Pederson; the Disposal of Trade Sewage, by C. H Currie; Stream Pollution and Its Effects, by N. T. Veach, Jr. These papers were presented at the 8th Conference on Sewege Treatment.

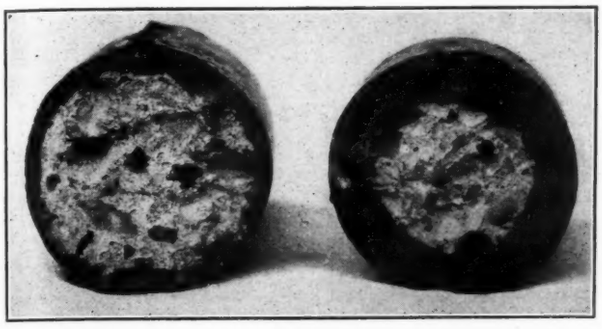
(Continued on page 52)

New Appliances

Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations

PROTECTAR FOR CONCRETE

The Barrett Co., New York, N. Y., has recently developed "Protectar," a specially prepared tar of such consistency and penetrative power that, it is stated, it enters readily into the outer layer of the concrete and, when sealed, protects it against the entrance of any other material. It may be used on either new or old concrete. The surface of the concrete should clean. Application may be by brush, spray nozzle or immersion.



4" CYLINDER. 1-2-4 CONCRETE. 4 COATS PROTECTAR PRIME. 1 COAT PROTECTAR SEAL.

4" CYLINDER. 1-2-4 CONCRETE. IMMERSED IN PROTECTAR PRIME FOR 1½ HOURS AND GIVEN SEAL COAT OF PROTECTAR SEAL.

Well made concrete, it is claimed, will absorb several paint coats of Protectar. Total immersion of the concrete in the tar for a period of an hour is considered the equivalent of 6 paint coats. The depth of penetration is said to vary from one-sixteenth to three-eighths of an inch or more.

The method of application is as follows: The surface to be treated is cleaned, and the "Protectar Prime" applied until no more can be absorbed—usually 4 to 10 coats. After the final priming coat has been absorbed, "Protectar Seal Coat" is used. About one-fourth gallon per square yard of priming coat and one-eighth to one-tenth gallon of seal coat are used.

Protectar is not intended to take the place of membrane waterproofing.

TRENCH ATTACHMENT FOR BAY CITY TRACTOR SHOVEL

The Bay City Dredge Works, Bay City, Mich., have just announced a trench attachment so designed that it can be attached to any Bay City Tractor Shovel. This attachment consists of an extension mast, boom and trencher bucket, and will dig to a depth of eleven or twelve feet, being suitable for basement excavation and water and sewer trenching. The machine has three speeds, the fastest 3½ miles per hour. It is one-man operated and equipped with full-crawler mountings, so that the bearing pressure is 5½ pounds per square inch. The McCormick-Deering tractor is used. This machine is designed for speed operation and is claimed to be the fastest propelling and operating shovel, crane, or trencher on the market. Standard bucket width is 24 inches, but slightly narrower or wider buckets can be furnished. The bucket dumps by inverting.

BROWN ELECTRIC FLOW METERS

The Brown Instrument Co., Philadelphia, Pa., manufactures the Brown electric flow meters for the measurement of fluids in motion. The electrical principle used is that of the self-balancing inductance bridge, the application of which to meters is claimed to be an exclusive Brown development. The flow of the fluid through an orifice produces a difference in pressure at two pressure taps which difference is transmitted to mercury contained in the manometer. The greater the flow, the greater the difference in the pressure.

Brown electric flow meters are of especial value in water works service, since water distribution, even in most distant sections, can be measured accurately, and flow at any desired points indicated, recorded and integrated. They are valuable for use in filter plants in checking the amount of raw water used and the filtered water from each unit. Many types of meters are made for other fields of work, as in gas plants, and in general industrial service.

This company also manufactures the Brown Pyrometer, which is designed especially for use with asphalt plants.

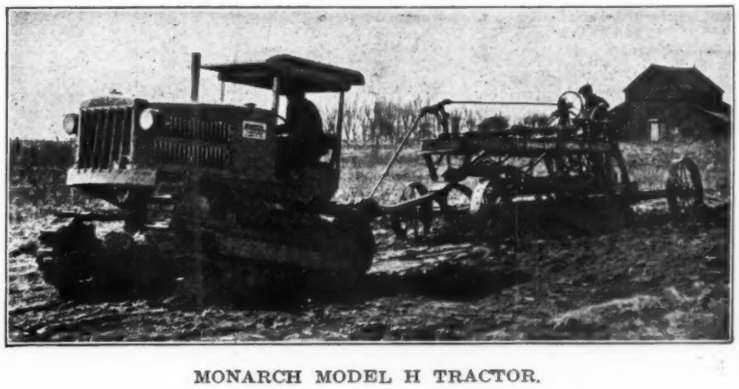
BAY CITY 16 B ¾ YD. TRACTOR SHOVEL WITH TRENCH ATTACHMENT.

MONARCH MODEL "H" TRACTOR.

Monarch Tractors Corporation, Springfield, Ill., has announced a new 6-ton tractor known as the model "H," which differs somewhat in appearance from other types of tractors, having exceptionally long track members, the body of the tractor is low, and the steering wheel and column are of the truck type.

This new tractor is powered by a 4-cylinder Stearns-Monarch motor, with 5⅛-inch bore and 6½-inch stroke, developing 60 horsepower. The crank shaft is 2⅞ inches in diameter, with extra large bearings. The transmission provides 3 speeds forward, 1.86, 2.82, and 4.07, and one reverse, 3.26, but the gear ratio can be changed by installing larger transmission sprockets. Steering clutches are of the multiple disc type, and are outside of the transmission case, allowing easy adjustment.

Power from the transmission is delivered to the track drive through two Baldwin roller type chains, of 2¼-inch pitch, with links of special alloy steel. The chains are short and operate on alloy steel sprockets with cut teeth, heat treated and hardened. All of the track sprockets are of ring gear type, with the sprocket rings bolted onto steel hubs. The track drive sprocket and the front sprocket rings are interchangeable. The rear chain sprocket and the track drive sprocket are both mounted on and oscillate with the track unit, which contributes to the flexibility and proper oscillation of the tracks and is made possible by use of chain drive.



MONARCH MODEL H TRACTOR.

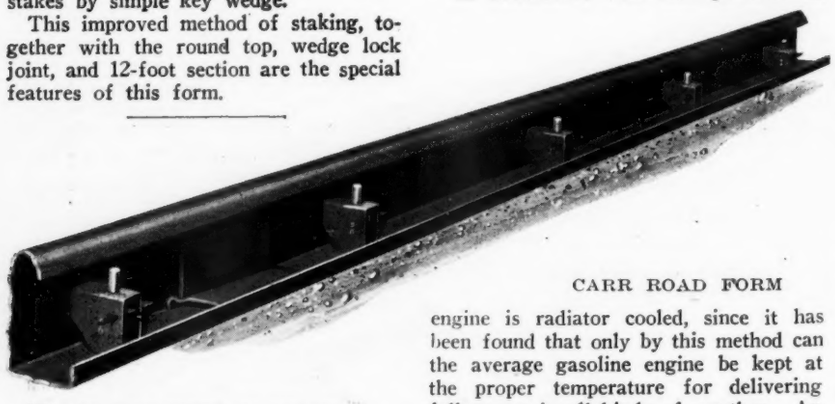
Special attention is called to the fact that this truck is built with a track link comprising a single drop forging. The shoe, rails, and the driving lugs are all forged integral, and being machined and carefully heat-treated there is provided a degree of durability and an assurance of long mileage which, it is stated, have not been obtainable in other forms of construction.

An exclusive Monarch feature is the complete electric starting outfit. In connection with the electric starter, a full electric lighting outfit is provided. The equipment also includes a canopy top over the operator's seat, metal guard for the front of the radiator, fenders and tools.

CARR ROAD FORMS.

The Lakewood Engineering Company, Cleveland, Ohio, manufacturer of the Carr Road Form, announces that this form is now provided with four stake pockets per 12-foot section. High carbon steel stakes, 7/8 inches in diameter, are used. The form is locked to the stakes by simple key wedge.

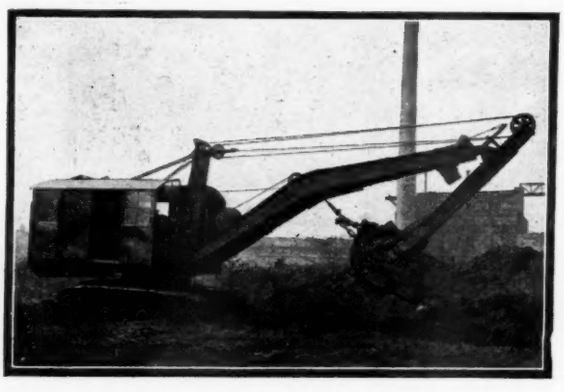
This improved method of staking, together with the round top, wedge lock joint, and 12-foot section are the special features of this form.



CARR ROAD FORM

P. & H. HOE WITH GOOSE-NECK BOOM

Harnischfeger Corporation, Milwaukee, Wis., announces a trench hoe with goose-neck boom. This improved hoe is one of eight attachments usable on machines manufactured by this firm. The goose-neck boom permits digging to a greater depth than is possible with the straight type of boom. The model 700, illustrated, will dig, it is stated, to a depth of 24 feet and has a working reach of 36½ feet. Harnischfeger Corporation is equipping the 1-yard and 1¼-yard machines with the goose-neck boom. Trenches from 38 to 52 inches wide can be cut, and wider trenches by shifting the dipper. The dipper used can be dumped from the front or bottom, and the dipper floor is provided with a special patented locking device.



P. & H. MODEL 700 TRENCH HOE WITH GOOSE-NECK BOOM.

FOOTE 6-CYLINDER PAVER.

The Foote Co., Inc., Nunda, N. Y., now supplies 6-cylinder engines as standard equipment on all paving mixers. The 6-cylinder engine used on the Foote pavers has been developed especially for heavy duty in industrial use. It is designed and built by the Continental Motors Company, of Detroit, Mich., and is made especially for heavy load continuous operation. Particular attention has been given to making it reliable and easy to maintain. It is known as type 8-B, and is rated at 53 H.P.

In accordance with best practice the engine is radiator cooled, since it has been found that only by this method can the average gasoline engine be kept at the proper temperature for delivering full power in all kinds of weather. An air cleaner is also provided, which eliminates much of the dust and dirt tending to accumulate in and on the engine.

SPARLING MAIN LINE METERS

R. W. Sparling, Los Angeles, Calif., manufactures the Sparling Main Line Meters, which are made in all even pipe sizes from 2 to 24-inch, with registration either in gallons or cubic feet. This meter is installed by cutting a hole in top of the pipe and bolting on the meter saddle. It may be mounted in suction or pressure pipes, horizontally, vertically, or slanting, with head upright or sideways. It is claimed to give accurate measurements on flows above about one-half foot per second, with a loss of head about equal to the friction loss through 25 feet of pipes of the same size. Additional advantages claimed are low first cost, simple and sturdy construction, resulting in ability to withstand long, hard usage, ease of installation, and protection of all working parts.

BLAW KNOX 5-TON TRUCK TURNTABLE MOUNTED ON WHEELS.

BLAW-KNOX PORTABLE TURNTABLE

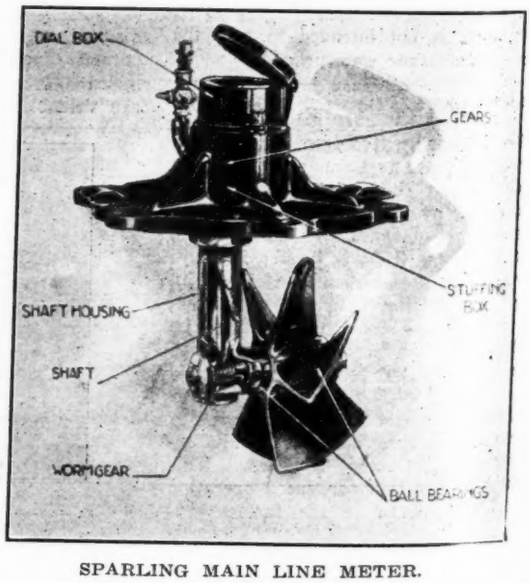
The Blaw-Knox Co., Pittsburgh, Pa., has made provision on Blaw-Knox turntables for the attachment of wheels, thus solving the problem of portability. The wheels can be attached in a few minutes by jacking up the turntable, and it is then possible to move it over soft subgrade, or transport it from place to place.

GURLEY LIGHTWEIGHT TRANSIT

W. & L. E. Gurley, Troy, N. Y., has announced a new light mountain transit which weighs only 9 pounds. Except in weight, this transit, known as No. 92-L, is the same as the No. 90 mountain transit. By extending the use of light alloy metals, the weight has been reduced, it is stated, without any change in size, quality, or general appearance. The 92-L has an 8½-inch telescope of 19 power and a 4-inch needle.

THE GENERAL EXCAVATOR

The General Excavator, manufactured by the General Excavator Co., Marion, O., is a one-half yard power shovel, convertible in the field to crane, drag-line, trencher, ditcher, skimmer or back filler. The conversion is merely a matter of



SPARLING MAIN LINE METER.

35,000 Lbs.

Experience Built This Shovel

THE Bear Cat has been built up from 24,000 lbs. to 35,000 lbs. in the last three years. Why? Because our wide experience has shown that most contractors and engineers demand a machine that is heavy enough to stand up under severe work.

The Shovel dipper has behind it 17 tons of weight and power and takes a full half yard in hard digging.

The Bear Cat is fast, with every attachment. It is economical. It will save you money.

Interchangeable Attachments

Send the coupon today for full information.
We can make immediate delivery now.

BYERS MACHINE CO., Ravenna, Ohio
Sales and Service Throughout the Country

BYERS MACHINE CO. Ravenna, Ohio
Gentlemen:— Please send me the new Bear Cat Book. The type of work I am particularly interested in is _____
Name _____
Address _____
Town _____ State _____
P.W. 6-27

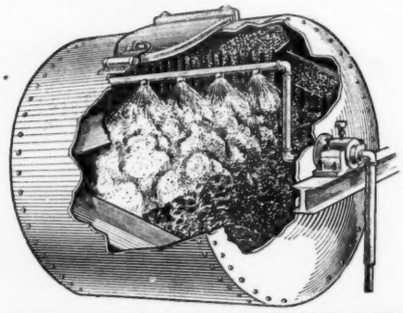
BYERS BEAR CAT

THE ALL-PURPOSE ONE MAN CRANE-SHOVEL-DITCHER

changing booms, accessories, and wire ropes, no additions or changes being necessary to the operating machinery. The General Excavator is designed to operate with gasoline engine or electric motor. Only one size and type is produced. This is of extra heavy construction, with ample reserve power to handle unusual overloads. It is claimed to have the ability to handle a larger yardage than any other machine of the same rating.

ROTARY PRESSURE ASPHALT MIXER

The American Fin-Mix Co., Chicago, Ill., has purchased the rights to the Finley rotary pressure mixer, which, it is claimed, makes possible the preparation of any type of hot asphaltic mix with greater uniformity and better results. Among the advantages claimed are ability to mix larger batches, resulting in

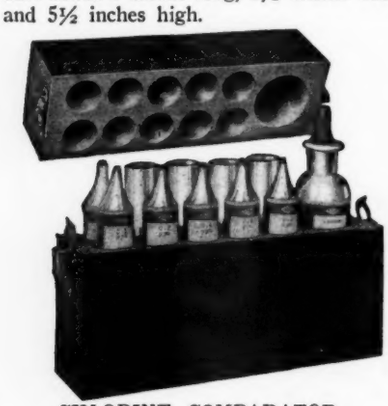


INTRODUCING HOT ASPHALT INTO MIXER

greater uniformity; better mixing of the asphalt, through atomizing and spraying of the hot material and by the maintenance of pressure during mixing; the use of larger sizes of aggregate than is now possible; no loss of dust, since the mixer is enclosed; and less replacements and power in operation.

ENSLOW CHLORINE COMPARATOR

The La Motte Chemical Products Co., Baltimore, Md., has placed on the market the Enslow Chlorine Comparator, a device for determining free chlorine in water. It is claimed that with this equipment the effects of color and turbidity in the sample tested are eliminated. Ortho-tolidine is used for the reagent and color standards in sealed glass ampules are provided with values of 0.1, 0.2, 0.4, 0.6, and 1.0 ppm. of chlorine. The equipment is contained in a polished wooden case about 8 inches long, 2½ inches wide and 5½ inches high.



CHLORINE COMPARATOR

This company also manufactures the La Motte swimming pool set, with which it is possible to regulate both the pH value and the chlorine content. Two chlorine standards only are furnished with this, 0.2 and 0.5 ppm., which are the lower and upper limits in usual swimming pool operation practice: pH indicators supplied are 7.2, 7.6, and 8.2.

NEW MARSH-CAPRON MIXER.

The Marsh-Capron Co., Chicago, Ill., has developed a new mixer especially for small paving jobs, sidewalk, or curb and gutter work. It is available in two sizes, one having a capacity of 30 to 90 yards per 8-hour day, and the other 60 to 125 yards, both of which are equipped with power loading skip, swing spout and distributing chute which can work through an arc of 180 degrees.

The mixer is so mounted that it can be changed quickly from end discharge to side discharge, enabling the machine to be used on alley work and other jobs where end discharge is necessary, while in a short time it can be converted into a side discharge machine for use as a standard mixer on building jobs.

On alley work the large machine has capacity for laying 160 lineal feet on standard 16-foot alleys 6 inches thick, based on a 1-2-4 mix. On straight curb work the capacity of the large machine using a 1-2-4 mix is about 800 lineal feet per 8-hour day. In both cases the smaller size can do about half as much On curb and gutter work the machine will do about half the number of lineal feet of straight curb.

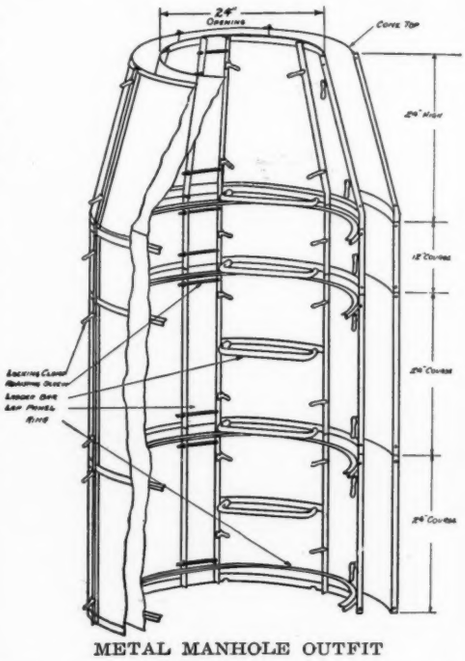
METAL MANHOLE FORMS

The Metal Forms Corporation, Milwaukee, Wisc., manufactures the Metaform Manhole Outfit, which is claimed to make possible concrete manholes at a minimum cost. In fact, it is stated that these standardized manhole outfits will cut construction costs about one-half, since two men can place the forms in one hour or less. The forms are built in units, and can be removed through the 24-inch opening at the top.

Complete units are furnished for diameters of 36, 42, 48, 54 and 60 inches, with inside forms only, or with both inside and outside forms. Cone tops of any dimension, as well as the standard 24-inch opening, can be supplied.

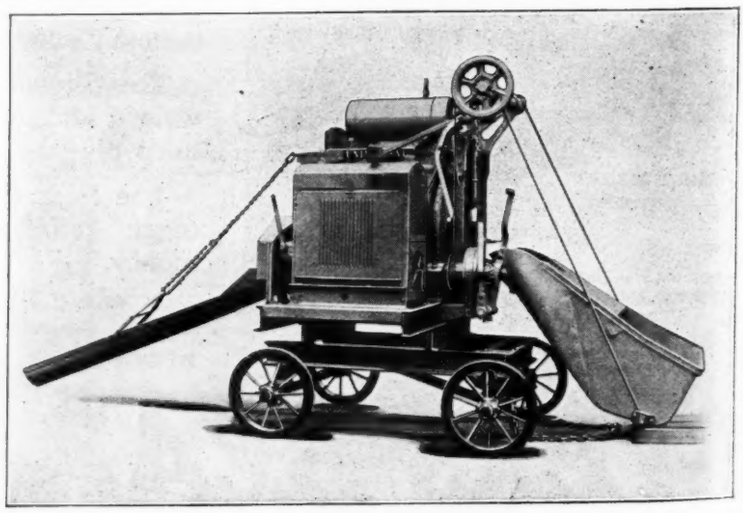
UNIVERSAL CRANE MOTOR TRUCK CRAWLER

The Universal Crane Co., Cleveland, O., has developed a new truck crane



METAL MANHOLE OUTFIT

mounting which is claimed to combine the mobility of a truck and the soft ground traveling ability of a crawler. This consists of an attachment that fits any ordinary 4-wheel truck, changing it into an 8-wheel, fully rubber tired truck, with 6 of these wheels grouped at the rear of the truck where a crawler track can be put around them, giving a full crawler rear end for soft ground travel. Only weight enough for steering is carried on the front wheels, but if the ground is too soft for any load, a spring



MARSH-CAPRON MIXER

backfill with a CATERPILLAR REG. U.S. PAT. OFF. TRACTOR

THE BACKFILLER replaces the shovel! Gasoline replaces sweat! Amazing are the reductions in the cost of filling ditches when the "Caterpillar" track-type tractor starts shoving earth in wholesale lots.

Gas and electric companies fill their ditches. Cities fill their sewers. Road makers fill in around bridge heads. Garbage is shoved over the dump. Oil companies fill in their pipe line trenches . . . .

Ask about the "Caterpillar" track-type tractor and the backfiller.

There is a "Caterpillar" Dealer near you.

PRICES

2-TON $1850 *Peoria, Illinois*

THIRTY $3000 *Peoria or San Leandro*

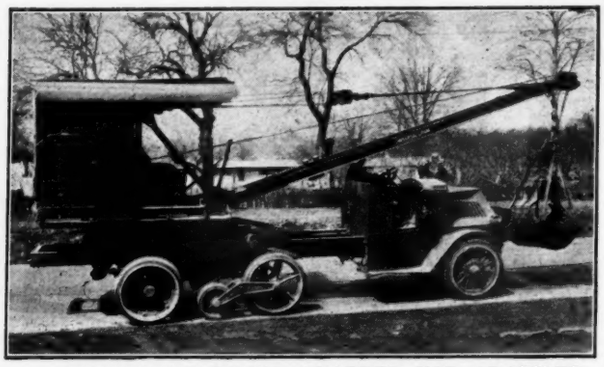
SIXTY $5000 *Peoria or San Leandro*

CATERPILLAR TRACTOR CO.

Executive Offices: San Leandro, California, U. S. A.
Sales Offices and Factories:
Peoria, Illinois San Leandro, California
Distributing Warehouse: Albany, N. Y.
New York Office: 50 Church Street

BEST C. L. Best Tractor Co. — *Successor to* The Holt Manufacturing Company — HOLT

better quicker cheaper



UNIVERSAL CRANE ADAPTED FOR CRAWLER ATTACHMENT.

adjustment permits the transfer of all the load to the crawler, the unit then being steered by an attachment controlling the crawlers. As a crawler, the speed of travel is 6 to 8 miles per hour; as an 8-wheel truck, the speed is 15 or more miles per hour. The crawler track is carried just above the rear wheels and, it is stated, can be attached by one man in about 5 minutes, without extra tools, excepting a hammer. Each tread has 30 inches of length on the ground, and treads are 15 inches wide, though treads 30 inches wide are available. The ground pressure is approximately 10 pounds per square inch.

KOEHRING 5S DANDIE SPEEDSTER

The Koehring Company, Milwaukee, Wisc., has developed a 5S mixer which, it is claimed, embodies the latest improvements making for fast operation, along with light weight, compact design and sturdy construction. It will handle a one bag batch of 1-2½-4 concrete. Designed for convenience and speed, the charging skip is low enough for wheelbarrow charging without building elevated runways or platforms. It is roomy and sufficiently long to chute the materials into the drum in one swift slide. The chute has a clearance of 27 inches, which allows wheelers to load barrows from the side or end according to the location of the mixer. The Koehring automatic water measuring tank is equipped with an indicator graduated in gallons for accurate and quick measurement.

Mounted on a narrow frame, equipped with either rubber tired or steel rimmed wheels, and with the weight of the drum over the rear axle it is quickly portable and easy to place in narrow quarters. Power is furnished by a single cylinder, 4 cycle Universal gasoline engine. The transmission is the worm drive type, completely enclosed and running in oil.

WESTERN MOTOR GRADER ATTACHMENT

The Austin-Western Road Machinery Co., Chicago, Ill., has just brought out the Western motor grader attachment for the 2-ton caterpillar tractor. It is claimed that this grader is adapted to practically all forms of country road or village street maintenance, and is also well suited to many ditching and light grading jobs, thus making it an all-around machine.

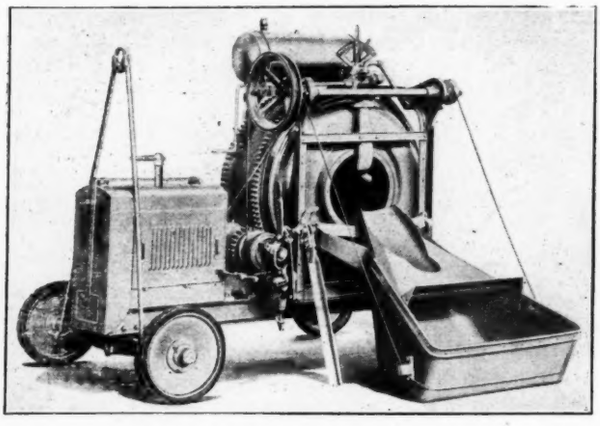
The side rails are 8-inch channels, securely cross-braced, giving a strong and rigid frame, so attached to the tractor as to allow complete freedom of movement without affecting the work of the tractor blade. The front end is heavy enough to insure good steering, and the grader is equipped with a truck steering mechanism. A steel cab with canvas curtains is provided for the protection and comfort of the operator. All worm gears are housed and run in oil. The scarifier attachment, which is of the A-shaped, self-cleaning type, is not standard equipment, but is furnished upon special order.

A NEW DIAPHRAGM FOR POWER PUMPS

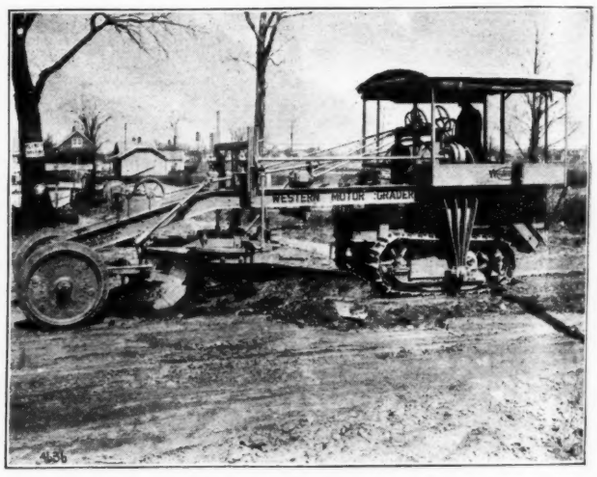
The Edson Manufacturing Corp., Boston, Mass., recently brought out the DP power pump diaphragms which are designed especially to withstand the increased strains and friction imposed by power pumps. The radical change in design consists of reverse curves, which straighten out on the upward and downward strokes of the pump, thus eliminating the friction and kinking of previous types of diaphragms. It is stated that these diaphragms have withstood 1,000 hours of consecutive pumping service. Another recent improvement is a soft round bead around the outer edge on the under side of the diaphragm, giving a tight fit between the head and the base of the pump.

WATER SOFTENER FOR HOMES

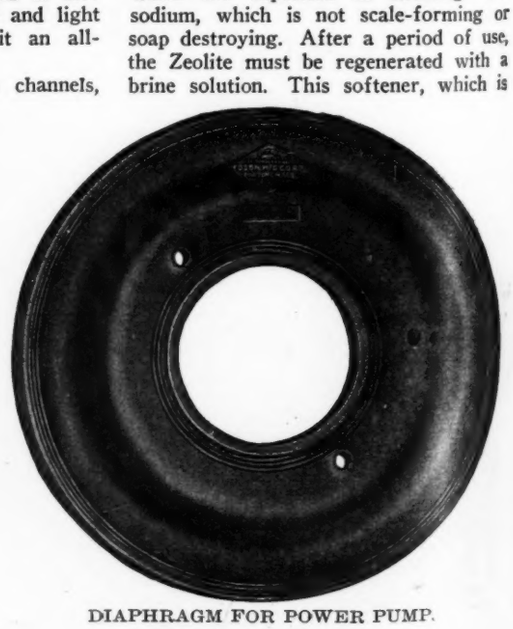
The Ward-Love Pump Co., Rockford, Ill., is furnishing a water softener for use in homes and apartment buildings. This utilizes the Zeolite process, whereby the hardness forming minerals in the water are deposited in exchange for sodium, which is not scale-forming or soap destroying. After a period of use, the Zeolite must be regenerated with a brine solution. This softener, which is



KOEHRING 5 S DANDIE SPEEDSTER.



WESTERN MOTOR GRADER ATTACHMENT.



DIAPHRAGM FOR POWER PUMP.

HUMDINGER PUMPS

For the Contractor

The open discharge type for lifts up to twenty-five feet. The diaphragm force type for deep excavations up to fifty-foot head and when it is desirable to lead the water away from or above the pump, all types will handle large volumes of sand, mud, etc., without clogging.

Manhole and Cesspool Cleaning

The **HUMDINGER** Diaphragm Force Pump is especially effective on rapid, odorless pumping of this nature and is perhaps more widely used than any other pump on the market.

Sewage Disposal Plants

The closed discharge **HUMDINGER** fills a real need in this field for sludge pumping, cleaning septic tanks, washing down, breaking up scum and opening blocked sewers.

An Ideal Municipal Pump

Trailer Mounted

NEW YORK
G.M.GEST ENGINEER AND CONTRACTOR CONDUIT WORK A SPECIALTY
WOOLWORTH BUILDING

New York City, December 30, 1926.

Ralph B. Carter Company,
126 Chambers Street,
New York City.

Gentlemen:

The following is an excerpt taken from one of our weekly news letters from our Superintendent, Mr. J. E. Donnelly, who has been with us for twenty years. We think that this might be of interest to you.

"Please find enclosed photographs showing pump in action. You will note that it has pumped approximately five cubic yards of sand, which have been shovelled to the side, and 4" of sand remaining in the runway of the pump. We encountered water and quicksand 8" below the paving, it being necessary to use pumps throughout the entire job, and the pumps were put to extreme test. We greatly appreciate the service our Humdinger pump has rendered, and sincerely recommend them.
(Signed) J. E. Donnelly."

We are enclosing herewith photographs referred to above.

We have now discarded our other pumps and are standardizing on the Humdinger.

Yours very truly,

J.H.G.:M.S.

Send for Complete Bulletin

RALPH B. CARTER CO.

126 Chambers St. New York

known as the Crane-Warlo Electro-Matic, is nearly automatic in operation, it being necessary only to keep the current turned on and the brine tank charged. The need for an additional supply of salt is indicated by an automatic signal.

SEALTIGHT EXPANSION JOINTS

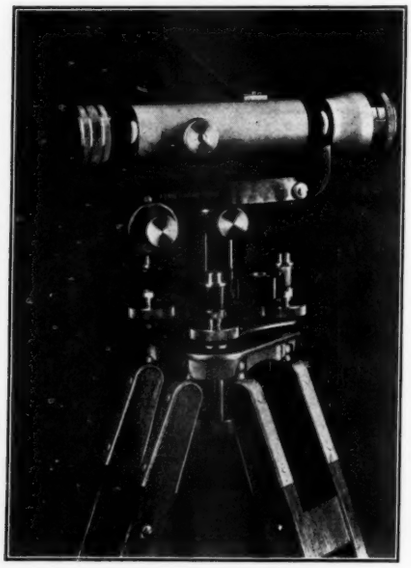
W. R. Meadows, Inc., Elgin, Ill., manufactures Sealtight road expansion joints, which, it is claimed, have the advantage of being impervious to weather conditions and of securing better adhesion to the concrete, while not requiring reinforcing of the sides. This prevents water or dirt from entering the joints, since it is at all times filled with Sealtight. While the melting point of the material is low, it is stated that the joint will not run in hot weather, due to the retarding effects of the long fibre filler used in the construction of the joint. Sealtight joints can be handled easily in any weather.

THE TRAYLOR VIBRATOR SCREEN

The Traylor Vibrator Co., Denver, Colo., manufactures the "Screen Supreme," which, it is claimed, is a marked improvement in screening devices, in that it has greater capacity and higher efficiency, at less operating cost. By an electrical device, rapid vibrations of small magnitude, are produced, which, according to the manufacturers, cause more efficient screening, while allowing greater capacity. The power used is said to be very small. This screen has no moving parts that wear and require replacement, and requires no lubrication.

KERN LEVEL II

R. W. Cramer & Co., Inc., New York, are sole distributors for surveying instruments made by Kern & Co., Ltd., Aarau, Switzerland. The Kern Level II is claimed to be a very fine instrument suitable for all sorts of precise leveling. It is stated that this level retains its adjustment a very long time owing to its sturdy construction and to the protection of its sensitive parts. Adjustments can be made easily. The telescope is turnable and the bubble reversible. The objective is 30 m.m. and the magnification 24. Stadia reading is 100, and K is 0. The leveling level is reversible and of the sensitiveness of 15 seconds per 2 mm. The level is protected against sun rays by a turnable metal and glass housing, which is also the holder for the reading mirror. This level is furnished with either rigid or sliding leg tripods, which consist of bronze heads and wooden legs connected in ball joints.



KERN LEVEL II

DOWEL SOCKETS.

The Dallas Brass and Copper Co., Chicago, Ill., has announced the manufacture of steel tubular dowel sockets or expansion tubes. These are used in transverse joints in concrete pavements to provide for the slippage of dowel bars, and take the place of plugged pieces of pipe and other expensive or unsatisfactory substitutes. The socket is flattened at one end to prevent wet concrete from entering, and has a stop placed so that the dowel bar will not reach the end, but will have plenty of air space. These sockets are made regularly in lengths from 6 inches to 18 inches, but can be made any length required; several diameters are provided to care for the various sizes of dowel bars in use. This product is stated to be very cheap, and at the same time sufficiently rugged to withstand any conditions of use.

INDUSTRIAL NOTES

PREST-O-LITE SELLS BATTERY BRANCH

The Prest-O-Lite Co., Inc., N. Y., has sold its storage battery branch to the Prest-O-Lite Storage Battery Corp., which is owned by the Automotive Battery Corp., N. Y., and a portion of the Indianapolis plant has been leased to the new company. The Prest-O-Lite Co., Inc., will continue in the acetylene gas field.

KENSINGTON STEEL COMPANY

Kensington Steel Co., Chicago, Ill., announces the appointment of Arthur Whitecraft as eastern sales manager, with headquarters at Port Ewen, N. Y. Mr. Whitecraft has been engaged in the managanese steel foundry business for the past seventeen years, his experience including engineering, sales and foundry operation.

CLEVELAND TRACTOR CO.

The Cleveland Tractor Co., Cleveland, O., announced the recent sale of 29 Cletracs to the Tennessee Highway Department.

MARSH-CAPRON DEALERS

The Marsh-Capron Co., Chicago, Ill., announces the appointment of the following dealers: National Machinery and Equipment Co., Seattle, Wash.; Marble, Cement & Coal Co., Muskegon, Mich.; S. M. Caldwell, Rockford, Ill.; A. W. Sikking & Co., Springfield, Ill.; R. S. Smilie, San Francisco, Calif.; Burke Machinery Co., Portland, Ore.; Ben Nieboer, Grand Rapids, Mich.; Bashford-McCord Corp., Rochester, N. Y.

KENNEDY VALVE MFG. CO.

The Chicago branch and warehouse of the Kennedy Valve Mfg. Co. has been removed to 1335-1337 South Clinton St., in the new Soo Terminal.

H. BURDETTE CLEVELAND MOVES

H. Burdette Cleveland, consulting sanitary engineer, has removed his offices to the Transportation Building, 225 Broadway, N. Y, from 38 Park Row.

BARKER & WHEELER

Barker & Wheeler, engineers, of New York, Albany and Atlanta, have moved their New York office from 90 West St. to 9-15 Park Place.

WHITE TRUCKS REDUCED

The White Company has announced a reduction in the price of two truck models. The models affected are the Model 15, three-quarter to one-ton capacity, and the Model 20, one and a half-ton. This reduction in prices brings the White Company into the light delivery field.

NEW OFFICERS FOR CHAIN BELT COMPANY

The Galigher Co., Salt Lake City, Utah, is now a branch office of the Chain Belt Co., Milwaukee, Wisc. An office has also been opened recently at Birmingham, Ala.

Fire recently destroyed the testing laboratories of the Dorr Co., located in the Westport Mill. The mill will be rebuilt immediately by the Dorr Co.

R. W. Cramer & Co., New York, N. Y., is American distributor for Kern transits, levels, optical instruments, engineers' cameras and drawing instruments; Favarger clocks, time devices, gages, and recording instruments; and Sauter time switches, motor operated and remote control switches, and electric temperature and pressure regulators.

CELITE FOR CONCRETE PILES

In connection with the Port of Oakland, Calif., development project, the first unit of which is being built by Smith Bros., Dallas, Tex., 3 pounds of celite per bag of cement is being used to insure uniformity and watertightness in the concrete piles to be used in the work. These are 15 to 18 inches square, and 40 to 60 feet long. The concrete mixture is designed for a 28-day strength of 2,000 pounds, but actual tests have shown averages of 3,200 to 3,500 pounds.

CELITE PRODUCTS COMPANY'S LECTURES

Col. H. C. Boyden, lecturer on cement and concrete, has joined the staff of the Celite Products Co. Col. Boyden will give a series of lectures, principally to engineering societies and associations and engineering colleges throughout the United States and Canada.

HARNISCHFEGER OPENS BALTIMORE OFFICE

The Harnischfeger Corporation, Milwaukee, Wisc., announces the opening of a Baltimore office at 1402 Lexington

"WATCH DOG" WATER METERS

Three Cities in This Country

Have Purchased

300,000 "WATCH DOG" Water Meters

In one of these cities there are 176,000 meters of our manufacture in daily use.

Although we supply some of the largest users of water meters, yet we furnish meters to some 2000 municipalities, the annual requirements of each ranging from 10 meters to 1000 meters, and we are always glad to furnish information and prices upon request.

Incidentally, we will be glad to submit our product for any legitimate comparative test.

GAMON METER COMPANY

CHICAGO
360 N. MICHIGAN AVE.

Main Office and Works
NEWARK, NEW JERSEY

SEATTLE
1410 L. C. SMITH BLDG.

Building, under the management of Daniel J. Murphy, formerly manager at Dallas, Texas.

PORTLAND CEMENT ASSOCIATION

H. R. Albion has been appointed district engineer in charge of the Jacksonville, Fla., office of the Portland Cement Association.

PROF. PHELPS WITH PARADON CO.

Professor Earl B. Phelps of Columbia University has joined the staff of the Paradon Manufacturing Company, Arlington, N. J., as technical consultant and research chemist. Professor Phelps is widely known in the field of sanitary engineering. He was formerly professor of Sanitary Chemistry at Massachusetts Institute of Technology and was afterwards for a number of years with the U. S. Public Health Service. He has long been identified with the development of chlorination, being one of the early pioneers in this work, particularly in the chlorination of sewage.

PARADON MOVES

The Paradon Manufacturing Co., has recently moved from Long Island City, N. Y., to larger quarters at 573 Elm St., Arlington, N. J.

HOVEY PRESIDENT OF FAIRBANKS-MORSE

W. S. Hovey has been elected president of Fairbanks-Morse, which organization has taken over the scale business of the Fairbanks organization.

PUBLIC REPORTS

(*Continued from page* 40)

Fire Prevention Activities; Inspectors and Inspections. Engineering Extension Department, Iowa State College, Ames, Ia. 14 pp. By J. E. Florin. Presented at the Second Short Course for Fire Fighters.

Characteristics of Fire Streams. By Harry J. Corcoran. 12 pp., Ill. Engineering Extension Department. Iowa State College, Ames, Ia. Presented at 1926 short course for fire fighters held at Ames, Ia.

Fire Hazards in Iowa and Community and Fire Department Cooperation. By J. A. Tracey, 8 pp., Ill. Engineering Extension Department, Iowa State College, Ames, Ia. Presented at 1926 short course for fire fighters, Ames, Ia.

Intermittent Sand Filters. By Ernest Boyce, 8 pp. Ill. Engineering Extension Department, Iowa State College, Ames, Ia. Presented at eighth conference on Sewage Treatment.

Camp Sanitation. By C. A. Holmquist and Charles R. Cox, N. Y. State Department of Health. Issued by the Division of Sanitation. Ill. 61 pages. This bulletin covers the problems of selection of camp sites, insect control, camp equipment, water and milk supply, sewage and waste disposal, garbage disposal, camp supervision, and the operation of swimming pools. While information covering this ground is necessarily brief when condensed within the limits of 60 pages, much valuable information is clearly and succinctly given. The chapter on camp equipment is especially valuable. Sewage disposal is well covered, but a defective type of pit privy is illustrated, and the L. R. S. privy, to a description of which some space is devoted, is entirely unsuited to camp use. New York State regulations for camps are given.

The Design of Sewage Disposal Works, with Special Reference to Small Installations. By Henry Ryon. 21 pp. Ill. This is an excellent publication on the general subject of home, camp and institutional sewage disposal. The various methods of treatment adaptable are discussed simply and clearly. Data on the amount of sewage are especially good. Sizes recommended for settling tanks are somewhat larger than current practice, but should give excellent service. The section on secondary treatment takes up the subject from a new and valuable angle. A real use is the summary on features of design. Typical plans of installations are also given.

BOOK REVIEWS

Advances in Sewage Treatment. "Fortschritte der Abwasserreinigung" (Advances in Sewage Treatment) is the title of a book by Dr. Karl Imhoff, the second edition of which was recently published in Berlin.

The subject matter is grouped into sections covering processes for removal of sludge and sludge handling; processes for purification of the liquid sewage; and industrial wastes, home disposal plants, costs and bibliography.

The first section of the book, covering sludge separation and treatment, describes new screening and Imhoff installations in America, and discusses the digestion of sludge in two-story, separate digestion and flowing through tanks, and its dewatering in trickling basins and by other processes. The advantages and disadvantages of Imhoff and separate sludge digestion tanks are compared and their relative importance considered.

Sickerbecken (trickling basins) are described as shallow basins with a layer of underdrained filtering material through which the liquid sewage is withdrawn after deposition of sludge has taken place by plain sedimentation of the slowly flowing through sewage. Such basins are constructed in groups so that some are in use while others are being drained and sludge is drying and being removed. Their design and operating features are described in some detail.

Ponding and stream clarification processes are methods employed in special cases for providing plain sedimentation and deposition of sludge by the formation of pools on land or in stream channels respectively, and are of limited application. Storm water tanks provide sedimentation for flows in excess of the general volume of sewage flow of combined sewers and where complete treatment is not necessary.

Methods of gas recovery from digesting sludge are discussed. The average amount of gas obtained from Emscher tanks is 8 liters per day or 3 cubic meters per year per person contributing sewage. The gas is composed of: Methane, 80-85%; carbonic acid, 7-20%; nitrogen, 0-8%; and hydrogen, 0%.

The use of sludge lagoons in America and Germany is briefly touched upon and the disadvantages of the method clearly stated. Digested sludge is recommended for agricultural purposes, for reasons given. The use of raw sludge has numerous disadvantages which are enumerated.—*Public Health Engineering Abstracts.*

Canadian Municipal Directory, 1927. The Wisely Bragg Publishing Co., Montreal, Can. 200 pp. Ill. $2.50.

This book is divided into three parts, which comprise a directory, giving a complete list of the municipalities in Canada, with their officials; a reference section, dealing with municipal activities and statistics; and a buyers, guide.

TRADE PUBLICATIONS

Tarvia Road Book. The Barrett Co., New York, N. Y., 48 pages, Ill. A handbook of useful tables and information for highway engineers, contractors, and road builders. Among the tables are those giving weights per cubic yard of various materials. Spacing of covering materials, quantities, stone cost computations, and conversion units. There are also instructions for proper handling and unloading of tank cars, BMX and GATX, and Specifications for Tarvia A, B, and X, for resurfacing old macadam with Tarvia, and for Tarvia double seal pavement.

Sanitary Engineering Bulletin. The Dorr Co., N. Y. 16 pages. Ill. This booklet describes the application of Dorr equipment to the treatment of municipal sewage, but also gives information of value to the engineer regarding sewage treatment. The purification and softening of water supplies and the treatment of industrial wastes are covered briefly.

Novalux Traffic Signals. The General Electric Co., Schenectady, N. Y. 26 pages. Ill. Describes systems of traffic control and discusses the selection of the type of signals best suited to various conditions and their application to existing conditions of traffic, including irregular and 5-way intersections.

Pressed Metal Signs. Western Stamping & Mfg. Co., St. Paul, Minn., and Cleveland, O. 44 pages. Ill. This booklet gives a very complete list of standard highway signs and markers, with specifications and descriptions. Also signs, tags, etc., for all other purposes.